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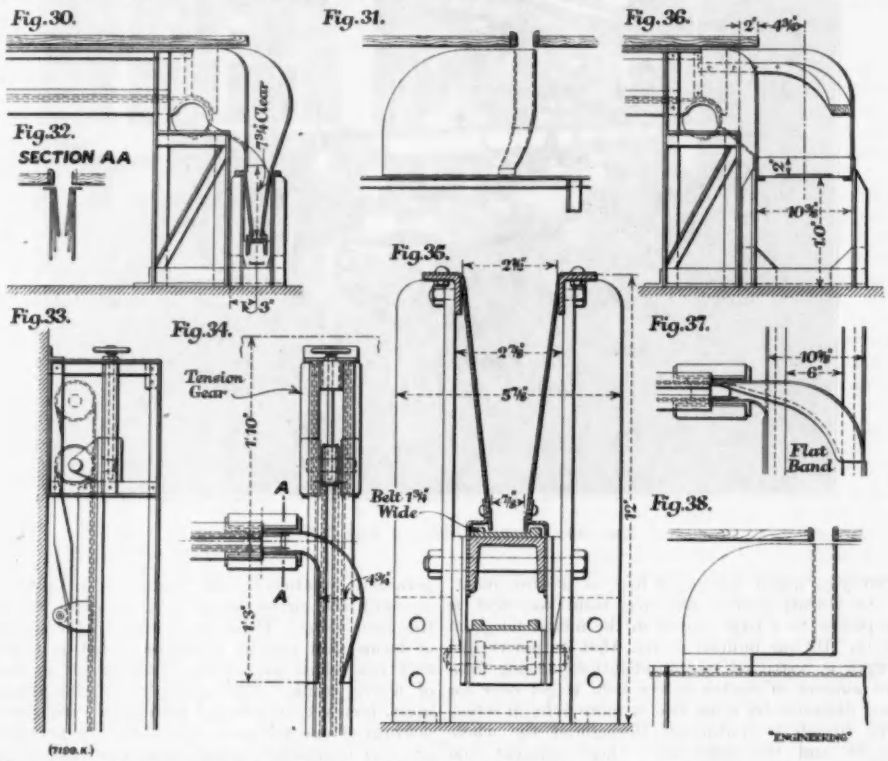
TELEGRAM-FORM CONVEYING SYSTEMS; GENERAL POST OFFICE—II.*

THE account of some of the telegram-conveyors employed in a number of the establishments of the General Post Office commencing on page 375 *ante* terminated with a reference to the drag-band conveyors and Vee-conveyors forming part of such installations. These conveyors may now be discussed in more detail, some typical examples being shown in Figs. 12 to 14, Plate XXIII. At the same time, it may be as well to describe briefly what is probably the largest installation employing them, viz., that in the inland telegram room of the Central Telegraph Office, St. Martin's-le-Grand. The layout of this room has already been outlined, but a much better idea of it can be obtained from the isometric view, Fig. 15, Plate XXIII. The primary circulation table and the two secondary circulation tables are seen at the centre of the lower leg of the H-shaped room, while, disposed in the other parts of the room, are 51 instrument tables. Both incoming and outgoing messages are handled at the instrument tables and the problem set the Post Office engineers was to collect the messages immediately they come in and to deliver them to the primary circulation table, thence to transfer messages for inland transmission to the secondary circulation tables, and finally to distribute them to the appropriate instrument table for transmission, mechanical means being used throughout.



The first stage consists of getting the incoming messages off the instrument tables with the least possible delay and with the minimum of movement of the operators. A Vee-conveyor down the centre of the table effects this, access to the conveyor being through a continuous slot within easy reach of the operators on both sides of it, the tables being 3 ft. 8 in. wide. An operator, on completing a form containing a message received, has merely to drop it vertically into the slot in front of her, when it is automatically carried away. On reaching the end of the table Vee-conveyor, the telegram form gravitates down a chute having a right-angle turn into a similar Vee-conveyor running just above the floor of the room across the end of a group of parallel tables. There are six such groups of instrument tables, each with its common collecting conveyor. It will be clear, however, from an examination of Fig. 15, that it would be impossible to lead the floor Vee-conveyors all the way to the primary circulation table, since this would render the gangways impassable. Moreover, the flow from the circulation tables could not be thus readily dealt with. This latter flow is, therefore, led overhead, as is the flow to the primary circulation table, where gangways have to be crossed. It is in connection with these overhead flows that the drag-band conveyor has proved so useful. These conveyors are arranged to travel vertically, either upwards or downwards, and either round right-angle corners or at various inclinations in a horizontal plane.

The lay-out of the numerous drag-band conveyors in the inland telegram room is much too complex to describe in the space available, but, as an illustration, the course of a telegram form from any position on instrument table No. 41 may be cited. Reference to Fig. 15 will show that the form passes to the floor Vee-conveyor at the end of which, viz., point *x*, it is transferred to a drag-band conveyor. This conveyor first takes the form up vertically, then overhead across the room and downwards vertically, delivering it into the floor Vee-conveyor of another group of tables at point *y*. Travelling along this second floor conveyor, together with the messages received from the second group, the form is again picked up, at point *z*, by a second drag-band conveyor, taken overhead across another part of the room and finally deposited by way of the screened drop-point seen in Fig. 1, Plate XXI, *ante*, on to primary circulation table. The total distance traversed by the form from the end of instrument table No. 41 is rather more than 275 ft., and the time taken from its deposition in the slot of the table Vee-conveyor to delivery on the primary circulation table is approximately 75 seconds. During this traverse the form passes five transfer points, the transfers being effected wholly mechanically; that is, no manual handling is needed from the time an operator has dropped a form into the slot of the table Vee-conveyor until the sorter picks it up from the slow-moving belt of the primary circulation table. It should be noted that during busy periods the forms are delivered on to a platform placed above the slow-moving belt on the primary circulation table. The forms are removed from the platform by hand and are faced, *i.e.*, arranged correct side up, before being placed on the slow-moving belt.

The time just quoted may not seem to offer any advantage over hand delivery between the two points since the average speed works out to only 2·5 miles per hour and messengers could move faster than that, but anyone who has witnessed the stream of telegram forms that flows down the table conveyors can realise at once that a very large number of messengers would have to be employed if the flow were not to be periodically delayed until a number of forms had accumulated. As it is, the flow is continuous and the form is started on its way immediately it is completed. Again, the typical journey cited above may, at first sight, seem needlessly complicated, but the complexity arises from precisely the same conditions as obtain in the Mount Pleasant letter-sorting and parcels-sorting offices, namely, that the plant has had to be planned to suit a building designed for quite other conditions. The tables, however, with the present arrangement of conveyors, are reasonably accessible and the gangways are not congested by hurrying messengers.

The drag-band conveyor illustrated in Figs. 16 to 18, Plate XXIII, is only a small one and is not used in connection with the instrument tables of the inland telegram room, but it has been selected as an example since it shows, compactly, the main principles of the system. It is used for transporting forms from one room to another on the same floor. It must be understood, in the first place, that in all drag-band conveyors the belt is not of a width sufficient to cover the telegram form, whichever way that form may lie, but is only 1¾ in. in width and runs in a trough 3¼ in. wide, having inclined upturned edges. The construction, as used in the Central Telegraph Office, is shown in the cross-section, Fig. 26. Since installation there, however, experience has shown that still better results are obtained by reducing the area of contact between the belt and the trough and, in consequence, the area of contact between the under surface of a telegram form and the trough. This reduction of contact area is effected by impressing the centre of the trough with three longitudinal ribs, as indicated in Fig. 25, which shows the cross-section as adopted in the Edinburgh General Post Office. A view of a drag-band conveyor in that office is given in Fig. 14. In the centre of this view the corrugated nature of the trough is clearly visible on the vertical member of the conveyor seen at the left centre. As the back of the trough is there seen the belt does not show, but a telegram form in transit, and showing up against the dark background of the door behind it, illustrates very well how the form overlaps both belt and trough. It might be thought that the projecting edges of the form would be crumpled, if not torn, during its circuitous transit, but such is not the case, the forms being conveyed from point to point without the slightest damage.

From the general arrangement views of the small installation, given in Figs. 16, 17, and 18, it will be seen that the system comprises a loading point at a sorting table; two vertical legs with an overhead horizontal traverse joining them and having a right-angle turn in plan; and a discharge point delivering on to a slow-moving flat belt. The drag-band conveyor belt is, of course, continuous and, since the traffic in this case is one-way and the return strand is idle, this strand does not run in a trough but is supported by idler rollers. The tensioning gear is arranged on the return strand in a loop between the driving pulley and the loading point, as is shown at the right of Fig. 16. Detailed views of the loading point are given in Figs. 23 and 24, Plate XXIII. In this particular installation, the telegram forms are loaded through a slot, leading to a short chute, on the sorting table. It will be realised from a consideration of Fig. 23 that when a form is inserted in the slot it is caught between the belt running over the bottom of the chute and an idler roller over which the belt is led, thereafter proceeding in an upward vertical direction. The belt is supported at the bottom of the chute on a smooth plate offering no resistance to the form. As the form leaves the roller it is led on to the vertical part of the trough by a pair of fingers, which embrace the roller and are simply portions of the trough flanges bent backwards. A similar device is used at other points involving a change of direction, a typical instance being the turn from the top of the vertical leg to the horizontal portion of the belt, as shown in Figs. 19 and 20, Plate XXIII.

* Part I of this series appeared on page 375, *ante*.

An application of the drag-band conveyor, again at the Edinburgh General Post Office, is seen in Fig. 12. Here, towards the right, are seen two conveyors. These pick up from two flat belt conveyors running above the top of the segregation table and deliver to the telephone-telegram and phonogram tables, respectively, in another room. The trough of one of the conveyors can be seen to the right of the left-hand stanchion and the return band to the left of the stanchion. The return band of the conveyor on the extreme right is used for conveyor forms from the phonogram table to the circulation table. The transfer from the phonogram table vee-conveyor to the return drag-band conveyor is seen in Fig. 14. It will be noticed that in both Fig. 12 and Fig. 14, the conveyor troughs are twisted, a condition which calls for some explanation.

The run of a drag-band conveyor in the horizontal plane, that is, when its surface is horizontal, presents no difficulty so long as it is straight, but it will be obvious that it is impossible for a flat belt in this position to deviate laterally by even the slightest amount. In the installation of Figs. 16 to 18, under consideration, a deviation through a right angle is required, as will be clear from the plan, Fig. 17. Both the trough and the belt between the corners of the horizontal run are, therefore, turned gradually from the horizontal plane to the vertical plane, that is, the belt first runs from a pulley having a horizontal axis to one having a vertical axis and subsequently vice versa. There is no difficulty in getting round a right-angle turn by this expedient and the form cannot slip out though it is held only by friction instead of lying on the top of the trough. The right-angle turn round an idler on a vertical axis is shown in detail in Figs. 21 and 22, Plate XXIII. The flattened fingers of the trough follow the contour of the roller so as to deliver the telegram form to the next trough in the series. This next trough lies, naturally, with its face vertical but, since it leads to the downward vertical leg of the system, it, also has to be twisted through a right angle so as to restore the belt to the horizontal before it passes over the idler at the top of that leg. The return strand is also twisted through a right angle on passing round the bend. The discharge of the telegram form at the bottom of the downward vertical leg is effected by flattening out and curving the trough, as shown in Figs. 27 28 and 29. In this installation, the form, when released, gravitates down a chute on to a slow-moving wide belt. The change of plane through 90 deg. when a drag-band conveyor has to be taken round a corner is seen as applied in the centre of the upper part of Fig. 14.

The change from movement in one plane to movement in another at right angles by twisting the trough and belt is also employed in the transfer of forms between Vee-conveyors and drag-band conveyors, such as occurs at points *x*, *y* and *z* in Fig. 15. In the case of a transfer from a Vee-conveyor the telegram form is delivered to the drag-band standing on its edge and at a slight angle to the vertical. A short horizontal portion of the drag-band conveyor has its trough and belt arranged in line with the side of the Vee-conveyor at precisely the same angle. As the form leaves this conveyor it is thus caught by the drag-band conveyor without change of plane, but, in order to lead the drag-band conveyor vertically upwards, the trough and belt are twisted later on. An arrangement of this kind is shown in Fig. 13. This is part of the installation at the Central Telegraph Office as originally planned. In the foreground is seen a floor Vee-conveyor which collects from instrument tables on the right during its course and from the drag-band conveyor seen running overhead in the background and descending vertically at the extreme left. The twisting of the troughs and belts to effect the change of plane is clearly seen in the top right-hand and bottom left-hand corners of the illustration. It may be noted, however, that, since the photograph from which it was produced was taken, the drag-band conveyor has been extended overhead to the primary circulation table, so that the forms go there directly and not by way of the floor Vee-conveyor. The conveyor seen at the centre of the upper part, is one belt of a multiple-band

TELEGRAM-FORM CONVEYING SYSTEMS; G.P.O.

Fig. 39. Inclined Floor Vee-Conveyor.

conveyor, which discharges here at a drop point.

As already stated, the drag-band conveyor is employed to a large extent in the inland telegram room. Its one limitation, viz., that its practicable length is restricted by considerations arising from the amount of stretch in the belt, is got over for long distances by using two or more belts in series. The trough is continuous throughout the whole length and the belts have their adjacent end pulleys very close together with the return strands running upwards out of the way. Both belts run at precisely the same speed and as the gap between them is only small the telegram form is caught at one end by the downstream belt before the other end is released by the upstream belt. The transfer is, therefore, effected smoothly and without the form becoming crumpled or torn. It should be noted that the drag-band conveyor is not always arranged in a manner similar to that shown in Figs. 16, 17 and 18. It is, for example, sometimes used to carry the telegram forms in both directions on the same floor; that is, the return strand also runs in a trough and both ends of the system have a loading point as well as a delivery point. Again, it may be employed as a means of transport to and from a floor above, as indicated in Fig. 12. In such a case the return strand may run alongside the delivery strand, the loading point being close to the delivery point, but, on the other hand, transmission to the floor above may be required at a point a considerable distance away from that at which transmission from that floor takes place. Instead of using two independent installations therefore, the "return" strand on both floors is taken from one point to the other on idler rollers and is not carried in troughs as these portions of the conveyor are not required to transport any forms. The drag-band conveyor is, in short, capable of a great deal of variation and in all its applications functions very satisfactorily. The belts are of raw-hide and undergo periodical treatment with castor oil in order to maintain the surface at the texture needed to drag the form along. There is no limit to the number of forms that can be conveyed; that is to say, they can follow one another quite closely at times of heavy traffic. The alignment of the troughs must, however, be effected with great care, since a hold-up of one telegram form due to a projection or other obstruction would cause the forms to pile up to that point and possibly damage them.

Although the drag-band conveyor is capable of transporting forms both vertically and horizontally without their transfer, it is sometimes found simpler, as when vertical transport only is required, to install what is known as a riser-band conveyor. This conveyor consists of a pair of belts running in contact with one another and its action resembles that of the multiple-band conveyor in that the telegram forms are sandwiched between the belts, which are, incidentally, much wider than the drag-band conveyor belts. The loading point is constructed with a pair of idlers very close together, so that the presented forms are drawn in between the belts. Conversely, the belts open out at the discharge point, which is more or less similar to those shown in Fig. 6, Plate XXI, *ante*. The belts are kept in contact in the vertical run by leading them through a series of staggered idlers, *i.e.*, over one side of one idler and over the opposite side of the succeeding idler, which arrangement causes the belts to travel in a slightly sinuous path. The automatic tensioning devices do not, however, function as well with two belts in contact as they do with a single belt, the result being that, when sudden climatic changes occur, the belts are apt to separate and the forms are, therefore, liable to fall out. This defect has now been overcome by twisting the belts through 180 deg. between the idlers, this expedient having the advantages that fewer idlers are required and that the speed may be higher than is practicable

with untwisted belts. Actually, tests at a speed of 1,000 ft. per minute have proved quite satisfactory, as regards conveying capacity, though such a high speed is hardly desirable on account of increased noise and greater wear and tear.

The general principle of the Vee-conveyor having already been described, some account may be given of its construction, reference being made, for this purpose to Figs. 30 to 38, page 429. It will be evident from Fig. 15 that the greater number of table Vee-conveyors, at all events those along the instrument tables, have to transfer the forms round a right-angle turn, such a discharge chute, from the table conveyor to the floor conveyor, being shown in Figs. 30 and 34. It will be noticed that the curved walls to give the required right-angle turn have not parallel faces but that the outer one has a relatively large conical contour and that the bottom of the chute terminates about 1½ in. above the top of the collecting Vee-trough on the floor. The reason for this is not apparent in Fig. 30, since this view shows the discharge chute from the first table of a group, but it will be readily understood that a clearance of this kind must be provided in order to allow telegram forms from all the tables to pass the chutes of those tables situated on their downstream side. The coned outer wall gives an easy descent to the telegram form, after it leaves the table conveyor, by absorbing its momentum and so preventing fluttering. The transfer is helped by the formation of the end of the table trough, which, as indicated in Fig. 30, projects beyond the end pulley, this projection consisting of a pair of plates inclined at an angle midway between that of the trough sides and the vertical sides of the beginning of the chute, as shown in Fig. 32.

An enlarged cross-section of the floor Vee-conveyor is given in Fig. 35. The top strand of the belt runs on the machined back of a channel iron, while the bottom, or return, strand is carried on idler pulleys. The belt is of rubber insertion and has a flanged cross section. On account of this flanging it must be twisted through an angle of 180 deg. at the turns between the top and bottom strands, in order to ensure contact of the flat side with the return idlers, otherwise the flanges might be damaged. This reversal is seen in Fig. 33, this view also showing the tensioning gear. On the Vee-conveyors for telephone tickets, however, the flanged belt has been dispensed with and a plain flat belt used. This functions equally well, since no tendency for the tickets to get under the edges of the trough sides has been observed, and this tendency was feared when the flanged belt was adopted for telegram conveyors. The flat belt does not require reversal between the top and bottom strands but, in order to prevent lateral displacement, the idler pulleys are flanged. In several instances, one of which occurs in the installation shown in Figs. 5 to 9, Plate XXI, *ante*, discharge of the table Vee-conveyor takes place, not into a second Vee-conveyor but on to a flat wide belt, the last return strand of the multiple-band conveyor being used for this purpose. The forms are required to lie flat on this belt so that it is necessary to turn them from a vertical position to a horizontal one as they pass from one conveyor to the other. Three views of a discharge chute of this type are given in Figs. 36 to 38, Plate XXIII. The turning over is effected simply and unfailingly by a curved wooden guide, having a bevelled edge, extending round the upper part of the outer wall of the chute.

The appearance of a floor Vee-conveyor is shown by Fig. 39, page 430. This view is reproduced from a photograph of the two instrument tables in the phonogram room at the General Post Office at Edinburgh. These tables, which are double-sided, have Vee-conveyors running down their centres and are cross-connected at one end by a floor conveyor. Normally, the flow along the front table is from right to left in the illustration, the forms as they reach the far end being picked up by the drag-band conveyors seen in Fig. 14, taken upwards and then transported overhead to the circulation table. The delivery end of the drag-band conveyor from one of the tables is seen in the centre of Fig. 11, page 376, *ante*. In certain circumstances, however, it is sometimes necessary to transfer messages arriving at the table in the background to the table in the foreground, so the Vee-conveyor of the former table is made reversible, *i.e.*, it can travel from left to right when required. These forms are delivered to the floor Vee-conveyor and delivered to the hopper seen at the end of the table in the foreground; from this hopper they are removed by hand to be dealt with and transferred to the Vee-conveyor on the front table. This view also shows very well the nature of the drives employed; individual electric motors are used wherever possible and the various conveyors are belt-driven from a countershaft which is belt-driven from the motor. Push-buttons are generally employed for control and various interlocking and signalling devices ensure safe working.

Although the pneumatic system for conveying telegram forms will be dealt with in some detail in a subsequent article, it is advisable to refer briefly to it here as some mechanical conveyors are concerned. Reference to Fig. 15 will show that the pneumatic tube terminals in the inland telegram room are situated against the wall in the same part of the room as are the three circulation tables. It consists, generally, of a long table, above which the pneumatic tubes terminate in the case of incoming messages and commence in the case of outgoing messages. The first class of messages consists of the completed telegram forms handed in by the public across the counter of such branch post offices in the London area as are connected by pneumatic tube to the Central Telegraph Office. The outgoing messages are those received in the Central Telegraph Office, which are addressed to persons within the districts of the branch offices already referred to. In both cases a form has to be actually handled. The form is enclosed in a carrier at the pneumatic table, for outgoing messages, and is received in a carrier at that table when it bears an incoming message. In either case, a good deal of labour would be involved if the forms were all transported, to or from the table, as the case may be, entirely by hand.

Dealing with the incoming messages first, the carriers containing these are automatically discharged from the tubes on to a slow-moving belt, which runs along the top of the table. Actually, this belt is divided at about its centre, one-half running constantly in one direction only and the other half being reversible. The object of this arrangement is to enable the whole of the carriers to be transported to one end or other of the table, or, in times of heavy traffic, one half of them to be conveyed to each end. On arrival at the ends of the table, the forms are extracted from the carriers and immediately loaded into a drag-band conveyor, which takes them to the primary circulation table for sorting and transport to the appropriate instruments by the route already described. There is a drag-band conveyor at each end of the pneumatic table, as will be evident from Fig. 15. The outgoing messages for the pneumatic tubes are delivered from the instrument tables on the forms which are received by the public, but some of them have to be put into envelopes and addressed before being inserted in the carriers. Addressing is done on the tables seen between the pneumatic tube table and the primary circulation table in Fig. 15. The forms are conveyed to the addressing table from the primary circulation table by one belt of the multiple-band conveyor, and the envelopes are then taken by hand to the pneumatic tube table, the distance between the two being only small. It will be noted in Fig. 15, that two tables close to the addressing table are concerned with registered telegraphic addresses. A large proportion of messages so addressed are for distribution in the London area, so that it is desirable to arrange for handling them close to the pneumatic tube table. The recording cabinets, etc., for decoding occupy one of the tables near the addressing table, and a Vee-conveyor runs down the centre of each table. Messages which have to be dispatched by way of the phonogram circuits, after having had the address de-coded, are deposited in the Vee-conveyor and are automatically discharged into a drag-band conveyor and elevated to the floor above, as shown in Fig. 15. This drag-band conveyor is of the two-way type, the return half transporting the incoming phonogram traffic directly to the primary circulation table. It may be mentioned, in connection with registered telegraphic addresses, that stencils are largely used for the full address on the envelope, since the traffic to a person or firm having such an address is generally fairly considerable.

It is advisable to repeat here that what has already been dealt with and what still remains to be described are typical examples only of conveying mechanisms, and that the accounts do not cover the complete equipment of the inland telegram room; neither is it confined to any particular post office. There are a number of variations to suit special conditions, but space limitations will not permit us to give a detailed description of them. Examples of such variations are, the method of transferring forms from a multiple-band conveyor to a drag-band conveyor; the arrangement of a multiple-band conveyor for both distribution and collection by utilising one of the belts for the latter purpose; and the methods of preventing telegram forms lying flat on a slow-moving belt from escaping. A few general comments may, however, be made. An all-round speed of 200 ft. per minute has been adopted for conveyance, this speed having proved the most economical one, allowing for wear and tear, noise and vibration. All idlers and pulleys are mounted on ball bearings of ample size and grease-gun lubrication is used throughout, the bearings thus needing attention at intervals of from two months to three months only. All slow-moving belts which pass in front of sorters run at a speed of 30 ft. per minute, tests, experience and observation having proved this rate to be the most economical speed for a belt from which telegram forms can be taken by hand for any economical length of time without fatigue. With the same end of reducing fatigue, all these belts are dyed green and the tops of the circulation tables are covered with material of that colour.

LITERATURE.

Instructions in Engineering Design. Vol. II. *Lattice Girder Bridge.* By PROFESSOR H. P. PHILPOT. London: Longmans, Green and Company. [Price 10*s.* 6*d.*]

THIS is the second of two texts for instruction in engineering design, produced by the Principal and Jodhpur Hardinge Professor of Technology of the Engineering College at Benares Hindu University. Professor Philpot will be well remembered as Professor of Civil and Mechanical Engineering at the Finsbury Technical College. Evidently his hand has not lost its cunning. It is quite an unusual piece of work, being a straightforward design, in very considerable detail, of a Pratt-type "through" railway bridge of 156 ft. span, to carry a single track (5 ft. 6 in. gauge), worked out in accordance with the British Standard Specification for Girder Bridges (No. 153, Parts 3 to 5), the Bridge Rules of the Government of India Railway Department, and the 5 ft. 6 in. Gauge Standard Schedule of Dimensions of the Indian State Railways. Sufficient extracts are given from these standards to avoid the necessity of direct reference. The scope is thus very narrow in one sense, but very broad in its details. As the author says, "The calculations given are such as would be recorded by the designer in his private notebook, while making to scale the working drawings upon which he depends for fixing many of the dimensions required by the workmen in the manufacture of the parts of the bridge."

The book will appeal especially to two classes of readers, technical instructors and bridge designers. Outside of India, both will doubtless demur to the use of Indian standards, although this is only an incidental feature of the specification. The educationalist may perhaps doubt the expediency of presenting the student with such a highly detailed study of one particular problem, since in the hands of the average student, lacking in initiative, it may become a literally inspired scripture or, alternatively, it may be neglected by all except those who have this particular type of problem to handle. John Perry would have termed it "spoon-feeding." The age-long controversy between the school which encourages the teaching of broad "principles," upon which the student can build, and the "practi-

cal" school which develops detail as far as time will permit, still remains unsettled; but it might be remarked that the average Oriental student, whose forte is memory rather than logic, much prefers the latter system, although it is less likely to produce engineering skill, *i.e.*, ingenuity. The practical designer will find much to interest him in the working out of details. Something might have been said with advantage about erection stresses, but the treatment of camber and deformation is excellent.

The book is clearly printed, with well-drawn sketches and four photographs of bridgework in India. Unfortunately, the author has not provided any list of contents or index—which is a rather serious omission. It is true that the matter "marches" step by step, like Euclid's "Elements," but, nevertheless, an index would be useful. The cover is of stiff paper, which, again, seems insufficient for a book which may have heavy use, but perhaps this is done to keep down the cost. It is to be hoped, however, that this is not a prelude to the adoption by English publishers of the Continental practice of producing books of permanent value in paper covers.

Mathematics Applied to Electrical Engineering. By A. G. Warren. Monographs on Electrical Engineering, Vol. IX. London: Chapman and Hall, Limited. [Price 17*s.* 6*d.* net.]

The conventional mathematical text is not, perhaps, as helpful as it might be to those who wish merely to employ mathematics as an adjunct in scientific investigation; in fact, their needs are not its primary objective. Almost inevitably it includes much that has little practical bearing, and often presents topics of current concern in a form so general as to be inapplicable. On the other hand, not infrequently it excludes matters of considerable practical moment such as effective computation methods. Moreover, the examples included usually bear little resemblance to real problems. The seasoned scientist may be competent to sort out the little that he needs from a mass of minutiæ that interests him not at all, but he cannot always spare the time to do so.

That great contributor of fresh mathematical techniques in the field of electrical communication, Oliver Heaviside, had a horror of this sort of academic mathematics, which he did not hesitate to express. He would have welcomed this attempt of Mr. Warren to render mathematics accessible to, and utilisable by, the electrical engineer. Even after making due allowance for the degree of selection implied in the title, it is no mean feat to start from the idea of number and to finish with the Schwarz-Christoffel transformation, in the space of 360 pages. His success is due partly to his consistent appeal to the physical implications of a problem to suggest the most suitable analytical procedure for its solution, but even more to his exclusion of all that is irrelevant to the main purpose. One of the most valuable lessons is that much needless effort can be saved by forming a clear physical picture before setting the mathematical mill into motion.

The introductory chapter, dealing with real and complex numbers and the properties of hyperbolic functions, is followed by the basic principles and working methods of differentiation and integration. Chapter V, "A brief survey of electrostatic, magnetic and electrodynamic relations," is a model of clarity and brevity, and should not be skipped even by those who can afford to do so. A selection of standard illustrative problems is succeeded by a chapter which, commencing with harmonic and vector quantities and concluding with symmetrical components, is likewise predominantly electrical in character. A short account of partial differentiation is followed by a more extended discussion of methods of integration introducing the beta and gamma functions. Most of the remaining space is devoted to differential equations. The linear differential equation with constant coefficients is considered, operational methods, based on the possibility of treating the symbol for an operator as an entity amenable to the laws of algebra, being introduced from the outset in solving it. The subsequent extension which operational analysis underwent at the hands of Heaviside is reserved for a later chapter. To illustrate the handling of simultaneous linear differential equations, the transformer, the single-phase alternator, the valve oscillator, the moving-coil speaker and the telephone diaphragm are considered in turn. A short discussion of the solution of differential equations in series precedes a chapter on Bessel's equations and functions. The importance of Bessel and associated functions is exemplified by their use in determining the distribution of alternating currents of various frequencies in solid or hollow cylindrical conductors, and in evaluating the eddy currents generated by fluctuating magnetic fields. The subject of partial differential equations, next treated, involves the consideration of various transmission problems. Fourier's series and harmonic analysis are admirably presented. The concluding chapter, concerned with conjugate functions, maintains contact with actuality to an extent which is rare. The appendices contain mathematical formulæ, electrical and magnetic equations, and a brief note on dimensions.

Only a few misprints were noted. On page 90, between 1·4 and 1·6 amperes, $\Delta\,\theta$ is 12 deg. and Δ L is 1·2 μ H. Judging from the data tabulated on page 301, Fig. 94 is inverted. On page 369, $F\,(a^2)\,\frac{\text{Sin}\,ax}{\text{Cos}\,ax}$ should read $F\,(a^2)\,\frac{\text{Sinh}\,ax}{\text{Cosh}\,ax}$; while, on the following page, the second form of the operational solution $(D^2 + a\,D + b)^{-1}.0$ corresponds to $a^2 < 4\,b$. Mr. Warren's book serves to vindicate the view expressed in the preface that, provided it is so thoroughly mastered as to be immediately and effectively applied, a modicum of mathematics is sufficient to cope with the normal run of electrical-engineering problems.

Statistical Method from the View Point of Quality Control. By Dr. Walter A. Shewhart. Washington: Department of Agriculture. 1939.

This book contains the matter of four lectures delivered by the author, who is a member of the technical staff of the Bell Telephone Laboratories in New York, to the Graduate School of the Department of Agriculture at Washington, and may thus be considered to be a report by an engineer to biologists on the application to engineering problems of statistical methods used in biology. The theory of statistics is steadily invading all fields of knowledge. In biology it has long since introduced a measure of order, in atomic physics its effects have been overwhelming, and the present work shows how it can be applied to mass-production problems.

Dr. Shewhart remarks that the idea of the mechanical "fit" of two parts was developed about 10,000 B.C. in the connection of stones and sticks, but that, until 1787 A.D., the notion of interchangeability was not clearly formulated. About 1900, the principle of definite standards was developed in Great Britain, proceeding by the "go" criterion and then by the "go and not-go," or tolerance limit, method which is now universal. He sees a new stage in progress in 1924 in the "quality control chart." In this the actual values of the quality—length, for example—are plotted on the base of the series number of the samples tested, in order to show how the values lie between the tolerance limits, or beyond them in the case of rejects. The author's theme is the systematic discussion of the manner of distribution of the values between these limits, or beyond them, so as to determine how far the fluctuations are due to the processes of production and to what extent the proportion of rejects may be reduced without uneconomical increase of production costs.

It is obvious that, if the distribution of the individual values follows the random or "Gaussian" rule, no indication is given of the causes of variation; except that, if the "modal" (typical or most frequent) value lies above or below the mean between the limits of tolerance, there is a bias towards one of the limits. If, however, analysis shows that the distribution is not random, but depends on some particular feature of the process, it may be possible to reduce the number of rejects by changing the process slightly. The author goes into the mathematical principles involved and the relation to the number of samples. He also draws an interesting analogy between specification, production and inspection in mass production, and hypothesis, experiment and "theory" in scientific investigation. He gives great attention to definitions, such as the difference between "accuracy" and "precision," and tends to be rather arid in places, but his methods and matter are excellent There is no index, and the examples chosen are not. perhaps, those which would appeal most to the mechanical engineer, but these are minor blemishes on a remarkable piece of work.

Engineering Physical Metallurgy. By R. H. Heyer. London: Chapman and Hall, Limited. [Price 25*s.* net.]

Text-books being available on the subjects of engineering metallurgy and physical metallurgy, it may be wondered what demand has led to the publication of a book on "engineering physical metallurgy." Since this volume is by a metallurgist of the American Rolling Mill Company, physical metallurgy might be expected to receive greatest attention where it concerns the practical and technical side. This, in fact, is the case; the author sets out with the declared intention of helping those making a first acquaintance with engineering metals and alloys, and of adapting his book for the instruction of non-metallurgical students. If he neither claims nor attains completeness, this is no adverse criticism of a work in which so many engineering and commercial aspects are stressed.

The first chapter, on "Pure Metals," deals briefly with single metals used in commerce (there are no "pure" metals so used in construction), and is followed by a similarly compact treatment of the principles of alloying. Methods of testing and the uses of the metallurgical microscope are not given; there are references at the end of a chapter to "appropriate" works, though these are entirely by American authors. It may be said, therefore, that the book is no substitute for the works of Rosenhain or Doan, or for English books on engineering aspects; it is rather a supplement, a guide to American viewpoints and, particularly, to American practice. All subsequent chapters bear out this point. White metals and light alloys, copper alloys and die casting, are dealt with, but three-quarters of the volume is taken up with iron and steel, including a chapter on welding and flame cutting. Cast iron and carbon steels, heat treatment of steel, low and medium alloy steels, high alloy and tool steels, surface treatment and steel castings are treated fairly fully. The long lists of references to current literature should prove advantageous to those who have little time to keep up with the vast output of works on metallurgical subjects. They incline towards the most recent articles rather than to reports of original investigations, but references to early papers can always be traced in existing text-books. The photographs and diagrams are reproduced with the high clarity indispensable in metallurgy. The book will prove of greater use to the engineer than to the metallurgist, and more particularly to those who seek information on what American industry is doing.

The Late Mr. E. E. Sidwell.—We note with regret the death of Mr. E. E. Sidwell, which occurred at his home on Friday, April 5, after a sudden illness. Mr. Sidwell, who was a director and secretary of Messrs. Brett's Patent Lifter Company, Limited, Foleshill Works, Coventry, was 57 years of age. He was educated at Bablake Secondary School, Coventry, and joined Messrs. Brett's Patent Lifter Company shortly after leaving school. He was appointed secretary of the firm in 1910, and was elected to the board of directors in 1937.

"Tin Farming" in Nigeria.—Whereas, in Malaya and elsewhere, the mining of tin involves the sinking of deep pits or the use of large dredgers, the methods employed in some parts of Nigeria are quite different. According to the monthly journal *Tin*, the tin ore lies on, or close to, the surface, and is won by a method known locally as "tin farming." It is stated that all the equipment required consists of mallets and hoes to break the ground, a number of receptacles to bring the "pay dirt" to camp, and a supply of strong canvas bags for the transport of the recovered ore. The "pay dirt" is brought in, sieved into the canvas bags, and is transported by donkeys or camels to the nearest railway or river. On reaching the coast, the ore is shipped to England to be smelted in Liverpool.

DYNAMOMETER FOR GROUND PRESSURES.

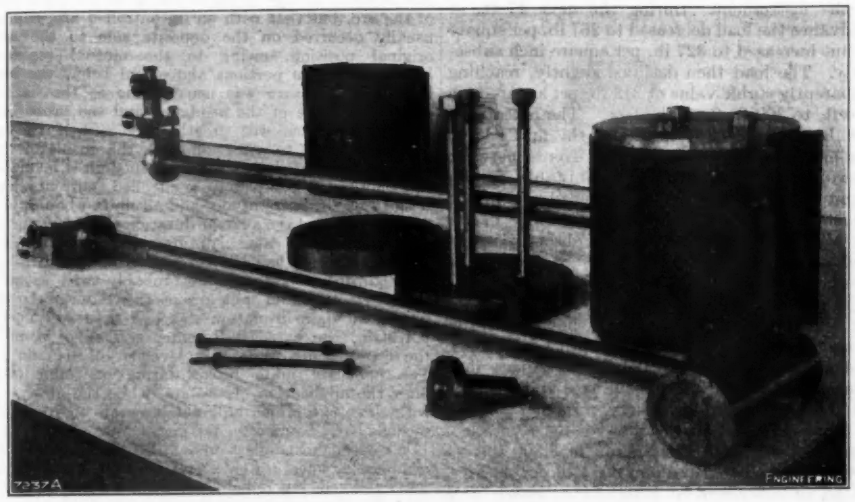


FIG. 1.

Fig. 2.

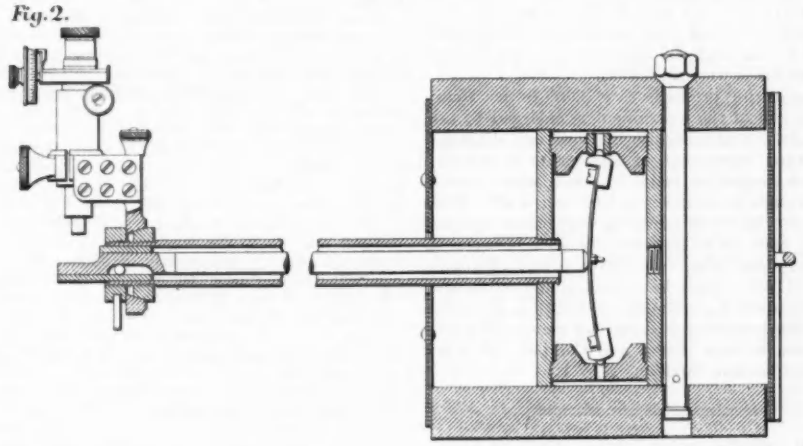
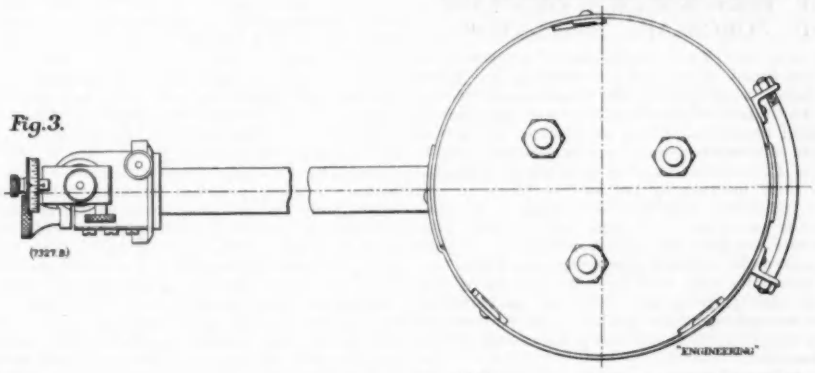
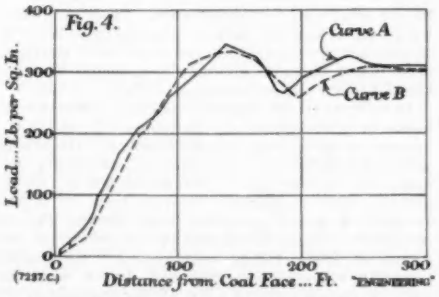
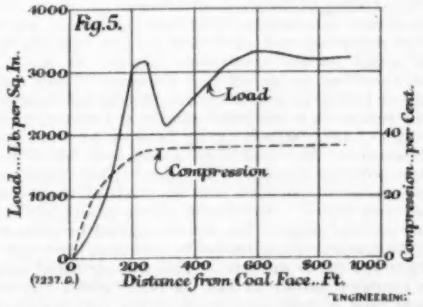


Fig. 3.







BLUE-PRINT PRESERVATION.—The protection of the working blue print from the dirt, oil, grease and water to which it is subjected in the shops has taken on a new aspect with the present paper restrictions, since a longer life means fewer prints. The introduction of a new proofing compound, known as "Fex," by Messrs. Firminger and Gregory, 1, Lonsdale-road, Kilburn, London, N.W.6, is, therefore, timely. The material, which may be thinned with water when required, is simply applied to the print with a brush and, when dry, forms transparent protective coating. As it is also a strong adhesive, it may be used for mounting prints on cardboard or for adding modified parts to existing prints. The makers claim that this method of protection may prevent costly mistakes from occurring owing to the mis-reading of partially obliterated prints.

DYNAMOMETER FOR MEASURING GROUND PRESSURES.

By W. H. EVANS, Ph.D., A.M.I.Mech.E.

THE instruments described and illustrated in this article have been made to the order of the Bangkok Dock Company, Limited, Bangkok, Thailand (Siam) for the investigation of ground pressures in connection with dock and harbour construction. They are of a type originally developed for the measurement of ground pressures in coal mines, which for the past five years have been used in the investigations of the Safety in Mines Research Board in order to obtain the precise data required for the more complete understanding of the complex movements of strata induced by mining operations. The ultimate object of this work is the reduction in number of casualties due to falls of ground in the mines. It may be useful to add for general information that falls of roof and sides are much the most serious source of accidents underground, although, occurring as they do, almost daily, and involving only one or two persons, they do not arouse public sympathy as does an occasional explosion or winding accident, with great loss of life.

A dynamometer was required to measure the loads on "packs," which in long-wall mining afford the principal support the strata receive after the coal has been removed. Packs are built systematically as the face advances by erecting dry-stone walls in pairs some 5 yards to 10 yards or more apart, and filling in between them with mine debris packed tightly to the roof. When the subject was examined, it appeared that only one previous worker had published results of a similar investigation. The tests were made in Germany, but they did not seem to have been particularly successful in technique or results, and received little attention. Several investigations have been made in America, both practical and experimental, on ground pressures of a different nature and lesser magnitude than those anticipated in mining; as, for example, of the pressures induced by rolling stock in railroad ballast, and against retaining walls. None of the methods used in these investigations was deemed suitable for use in the long-period tests under heavy loads which were envisaged in the projected investigations of loads on packs. It was necessary, therefore, to start afresh for the work in view.

In the early stages of design of the instrument, the measuring of loads of the required magnitude by the method proposed was investigated by laboratory tests carried out in a 400-ton testing machine at the Royal School of Mines, South Kensington. The specimens under load consisted of filled timber cogs about 4 ft. square and 5 ft. high; such cogs are used as permanent supports in coal mines. A circular hole was cut in the roof structure and a steel disc was fitted to it; the load on the disc was measured by a Wazan (mercury-displacement) dynamometer rigidly held in the roof framing. A number of tests with this apparatus showed that the method of trepanning one of the pressure faces and inserting a sensitive disc could be relied upon.

For the underground investigations an instrument was required which was simple, robust and reliable. Although in theory an area of 1 sq. in. would suffice to record the resistance of the pack, it was desirable to design the dynamometer to withstand the load induced on a fairly large representative area, because a pack is an agglomerate of material of various sizes. Consequently the load on the instrument tended to become large and its construction correspondingly heavy. Moreover, the instrument had to present a practically unyielding face to the oncoming load and at the same time to record that load. If there were any perceptible yield of the face erroneous results would be given, because the measured load would be less than that on the surrounding pack. Flooding of the site of a test and shot-firing in the vicinity were among the lesser factors influencing the design towards maximum simplicity and robustness.

With this preliminary statement of the function and conditions of operation of the dynamometer a description may be given of the two instruments referred to above, and illustrated in Figs. 1 to 3, on this page. The general form of the instrument when assembled was cylindrical (8 in. in diameter

and 8·5 in. high) with a tube projecting from the side. The top and bottom of the cylinder consisted of steel discs 1·25 in. thick and 8 in. in diameter, between which a single measuring cell was placed centrally. The function of the circular discs above and below the cells was merely to receive the oncoming pressure and transmit it to the cell. The elastic strain in the cell wall due to direct compression was measured by a device enabling readings to be taken some feet away.

Fig. 1 is reproduced from a photograph of one dynamometer partly assembled and Figs. 2 and 3 show a longitudinal section and plan respectively. The cell consisted of a hollow cylinder of nickel-chromium steel, 6 in. long and 3 in. outside diameter, with walls 0·375 in. thick. It was screwed internally at each end to receive caps which were seated in position 0·05 in. below the cylinder ends. The caps were made in mild steel with a deep skirt to ensure a high degree of stiffness. The upper cap was fitted with a central bronze adjusting screw, 0·625 in. in diameter, and screwed 26 threads per inch, through which a hole 0·16 in. in diameter was drilled axially. A similar hole was drilled in the bottom cap, and the inner edges of both holes were cupped very slightly to form seats. Inside the cell was a spring-steel strut of flat section, fitted at each end with a hard steel ball, firmly gripped and held precisely on the centre line of the strut. The balls engaged the seats in the end-caps and the strut could be loaded by means of the fine-threaded screw until it was deflected to the extent required. A strong steel tube was screwed into the side of the cell and projected horizontally a suitable distance—in the present instance 39 in.; a maximum length of 8 ft. has been used. Within the tube was a rod, one end of which was attached to the middle of the strut. The other end passed through a bush pressed into the outer end of the steel tube, and both bush and rod were cut away to the diameter at the extreme end. A single hard-steel ball *j* was used as a roller to take the weight of the outer end of the rod in the bush. A strong steel shield which fitted the two end discs was used to exclude foreign matter from the instrument.

The cell operates as a load-measuring device in the following manner: The load transmitted to the cell by the end plates produces a corresponding strain in the cell walls, and the stiff end caps approach each other by an amount equal to the total linear strain in the cell walls between the two cap seats. This motion is transmitted to the strut and causes an increase in its lateral deflection several times greater than the vertical movement. A magnification of movement in the ratio of 5 to 1 is obtained by this means. The lateral motion of the strut at its mid-point is transmitted by the rod to the outer end of the enclosing tube, where the flattened surfaces of both rod and bush (which are of stainless steel) are provided with fine marks. A mounting is carried on the end of the tube for attaching a microscope to read the relative displacement of the marks on rod and bush. The cell wall is stressed to 16 tons per square inch at maximum load and the total compression of the walls is approximately 0·0065 in. The full travel of the rod is 0·0326 in., or about $\frac{1}{31}$ in., and the displacement is measured by a micrometer-microscope graduated to read to 0·0001 in. Calibrations are carried out in a testing machine and a calibration chart is prepared giving the pressure in pounds per square inch against microscope dial readings.

Hitherto, the use of the dynamometer has been confined to mining investigations but they are obviously suitable for use in other branches of engineering, as, indeed, are the two instruments ordered by the Bangkok Dock Company. A few examples of the results obtained in British collieries will show the range of work already covered. The two curves shown in Fig. 4, page 433, represent the results of two tests carried out in succession in a shallow seam lying at a depth of 200 ft. Curve A was obtained in the first test and curve B (dotted line) in a repeat test made to check the highly interesting fluctuations in load first observed in test A. The dynamometer was set near the centre of a coal face about 200 yards long, which was advancing at the rate of approximately 15 ft. per week. As the face advanced, the load on the pack increased rapidly and fairly uniformly to a maximum of 345 lb. per square inch when the face had advanced 138 ft. from the instrument. During the next 47 ft. of face advance the load decreased to 267 lb. per square inch, but increased to 327 lb. per square inch subsequently. The load then declined slightly, reaching an apparently stable value of 312 lb. per square inch at 270 ft. to 300 ft. from the face. The repeat test (curve B) confirmed the results of the first test in all its major features. The lag in events between the two curves is probably attributable to the different behaviour of the overlying strata in the two tests; the rate of face advance is one of the many variables which may affect observations of this character.

Another investigation has been made in seams lying at moderate depths of the order of 1,000 ft. to 2,000 ft. below the surface. Fig. 5 shows the result of a test in a seam lying at a depth of 1,050 ft. A first maximum load of 3,194 lb. per square inch was measured at 234 ft. from the face and then fell to 2,112 lb. per square inch during a further 78 ft. of face advance. This was followed by a gradual increase in load until a maximum of 3,300 lb. per square inch was passed at about 600 ft. from the face. The load then declined to 3,200 lb. per square inch at 800 ft. from the face and remained nearly constant at this value until the test was stopped. This test was carried out over a period of three months. The dotted curve shows the percentage compression suffered by the material composing the pack under which the loads were measured.

For measuring pressures over 3,000 lb. per square inch, the cell of the instrument is enlarged to take two struts set at opposite ends of one diameter. The inward movement of the struts is recorded on a dial suspended inside the cell, which can be read through a window in the cell wall. These instruments have the advantage of greater compactness and allow of an increased distance between the instrument and the observation point. Dynamometers of this design have been made to measure pressures up to a maximum of 9,000 lb. per square inch. The instruments described were constructed by Messrs. George Wailes and Company, Limited, 382, Euston-road, London, N.W.1.

THE PERFORMANCE OF GLASS AND PORCELAIN INSULATORS.

The paper on "The Development of a Pre-Stressed Glass Insulator," which was presented by Mr. P. M. Hogg before a meeting of the Transmission Section of the Institution of Electrical Engineers, on Wednesday, April 10, and of which an abstract appears on page 449 of this issue, was supplemented by a report on "The Performance of Glass Insulators," presented at the same meeting by the British Electrical and Allied Industries Research Association. In this report the performance of glass and porcelain insulators were compared from the point of view of their behaviour under alternating-current power arcs and when heated by solar radiation. The results of tests to determine their impact resistance and impulse electric strength were also given and the performance of glass insulators in humid and polluted atmospheres was described.

The striking of an arc over an insulator, the report points out, was erratic. Standard conditions, which would render the test more uniform and reproducible and would, at the same time, increase its severity had, therefore, to be set up. Currents of from 250 amperes to 5,000 amperes were employed, the duration being restricted, in the latter case, to 0·5 second, while for arcs of 1,000 amperes it lay between 1 second and 2·5 seconds. The insulators tested were all of the suspension type having 10 in. discs. They comprised three makes of porcelain and one each of toughened glass and Pyrex. They were all of practically the same size and shape. The arc was started by connecting the insulator cup to the pin by a piece of bare copper wire 0·004 in. in diameter. This was stretched over the insulator surface in the direction which the arc would tend to take as a result of the field produced at the insulator by the current leads. At first no effort was made to control the arc's movements, which varied greatly in length and position, but subsequently the cap and pin were covered with insulation, except in the neighbourhood of the copper wire. For this purpose, a quartz cylinder with a small notch in its lower edge was placed over the cap, while plastic insulation was used on the pin.

Over 200 tests were made on 110 units, with currents ranging from 250 amperes to 1,000 amperes, and it was found that with the arc-control device just described the insulator always broke at the point of application of the arc, but that with an uncontrolled arc, rupture usually occurred on the opposite side to the arc's original position, owing to the mutual repulsion between the two portions above and below the insulator. The rupture was usually due to the heating of the underside of the insulator, and the probability of its occurrence was greatly increased if the arc remained fixed to one point on the insulator pin. The tests indicated that for toughened-glass insulators the minimum completely controlled currents that would cause rupture of any and all units when applied for 1 second, and the average duration of a 1,000-ampere arc required to cause rupture of individual units, were all greater than the corresponding quantities for porcelain insulators and were probably twice as great. When fracture did not occur the damage to the toughened-glass insulators was less than to those of porcelain, the corrugated under surface of some of the latter being practically levelled off by the arc. The porcelain units broke during or immediately after the application of the arc, while the glass units with three exceptions broke at intervals of from a few seconds to 27 hours after testing.

When toughened-glass units failed, the shed shattered completely, whereas four porcelain units and two Pyrex units cracked, but remained apparently intact, so that a faulty unit might remain undetected after arcing. When arcs of 500 amperes and 1,000 amperes, respectively, were each applied to one Pyrex insulator for 1 second there was little damage to the Pyrex itself, but considerable melting and vaporising of the lead in the seal took place. In practice, this would have a deleterious effect on the insulating properties of the lower sheds in addition to weakening the mechanical properties of the string. The arc duration required to cause fracture was not inversely proportional to the arc current but only to a power of about one half.

The British Standard temperature cycle test for porcelain insulators, which was designed to ensure against failure by cracking due to sudden changes of temperature, was too drastic for glass insulators, which did not heat up to the same degree when exposed to solar radiation. Consequently, a series of tests was conducted to determine the heating of the insulators. The results of these showed that if the surfaces were left clear, glass units would not be subjected to thermal stresses to the same extent as brown porcelain insulators, while the rise in temperature with white porcelain insulators was slightly less than with glass. The conclusions, however, had a limited practical value, since toughened-glass insulators would satisfactorily pass the British Standard test and the same was true of Pyrex, which had a very low thermal expansion.

The resistance of an insulator to the impact of a thrown stone was difficult to determine, owing to the many variables involved. However, a series of experiments using a hardened steel bob swinging on a silk line had been made, the bob being mounted so as to permit of tests on pin insulators at various angles. As a well-aimed stone would, in general, strike an insulator with sufficient energy to break it, the main question to be considered was the nature of the probable damage. When porcelain insulators were hit from above, only the top shed broke and large pieces fell off, but the fracture did not spread inwards from the point of contact. The shape of the insulator played a large part in its vulnerability. Tests were also made on glass insulators, and among the general conclusions reached was that if smooth stones only were available toughened glass was more resistant, but the damage suffered by the porcelain insulators was much less. After fracture the porcelain and Pyrex units would still support the maximum transverse load as against only 80 per cent. with toughened glass. Therefore, damage with a stone was less liable to cause a fault in the case of porcelain than glass. On the other hand, toughened-glass might be more resistant to glancing blows, but this depended also on the shape of the insulator.

In order to avoid insulators being punctured, a high factor of safety above the flash-over voltage must be applied to the impulse electric strength. The strength values for different materials were, therefore, determined by making special cups and testing them in glycerine for breakdown. Several tests on different samples of glazed porcelain cups showed dielectric strengths averaging about 500 kV per centimetre, while somewhat lower values were recorded for unglazed porcelain. Toughened-glass and Pyrex were both found to have a value of 1,700 kV per centimetre, while that for annealed glass was as high as 2,200 kV per centimetre. Finally, the performance of insulators in humid and polluted atmospheres was studied. The conclusion reached was that under these conditions the performance of glass insulators was not inferior to that of porcelain units of the same shape. In general, there appeared to be little difference in the surface characteristics of glass and porcelain insulators.

GRINDING AND LAPPING MACHINE FOR SINTERED-CARBIDE TOOLS.

MESSRS. W. G. BOWEN AND COMPANY (ENGINEERS), LIMITED, LONDON.

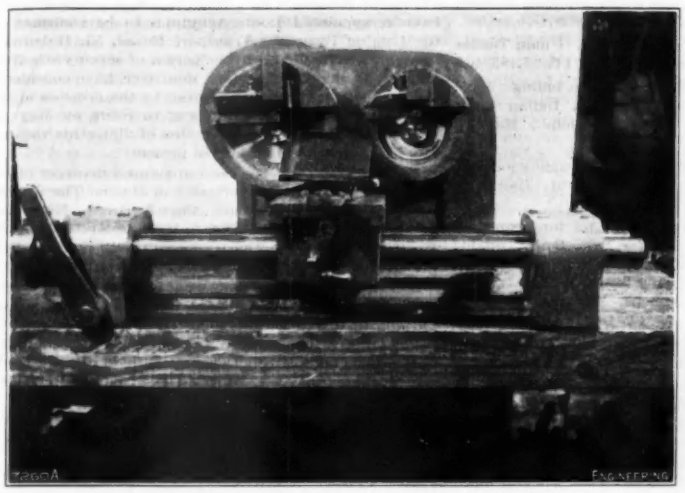
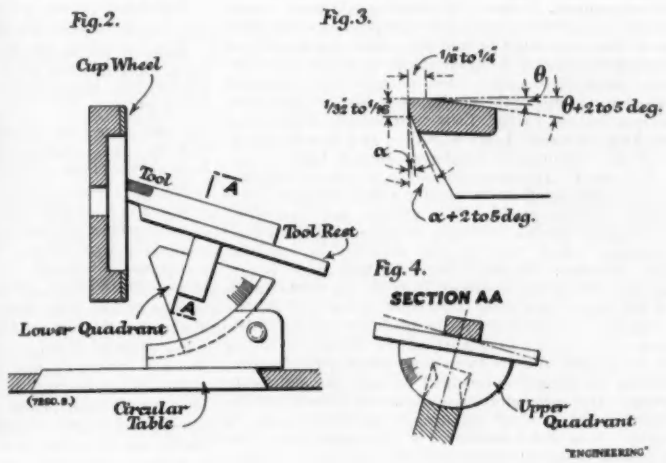


FIG. 1.



GRINDING AND LAPPING MACHINE FOR SINTERED-CARBIDE TOOLS.

If the most satisfactory results are to be obtained with sintered-carbide tools, which are now so extensively employed in the engineering industry, it is necessary that great attention should be paid to their grinding. Absolutely smooth edges are necessary on both the clearance and rake sides, and the exact cutting angles required must be maintained in all re-grinding and lapping operations. If the tool has a curved cutting edge, maintenance of exact radii is necessary. In the case of milling cutters, uniformity of teeth with respect to angles, diameters and planes of operation is imperative. The maintenance of a smooth cutting edge has many advantages from the point of view of production. In particular, it is desirable that the grinding and polishing marks should run parallel to the flow of the chips; this facilitates the flow, reducing power consumption and the heat generated, with a consequent reduced rate of wear on the tool edge. The resulting longer tool life improves production by cutting down the interruptions necessary for re-grinding and re-lapping, a further advantage being that the accuracy of the work produced will be maintained for a longer time. In obtaining the necessary high finish for the cutting edge, diamond grinding and lapping wheels have proved particularly valuable and it is desirable that a diamond lapping should follow the pre-grinding of the tool stock and the grinding of the carbide tip.

In maintaining exact cutting angles in re-grinding and lapping operations, proper control of the tool is essential. This may be obtained by means of two quadrants operating in planes at right angles as shown in Figs. 2 and 4. It is only by means of rigid control that the production of a uniform back-rake angle combined with rapid re-grinding, may be obtained. The use of a simple bar rest is still met with, but cannot produce satisfactory results with carbide tools. It is stated that a rest of this form tends to produce clearance and rake angles 2 deg. to 5 deg. larger than specified, so that the cutting face extends only on relatively short lands, possibly $\frac{1}{32}$ in. to $\frac{1}{16}$ in. wide on the front and side clearance angles and $\frac{1}{8}$ in. to $\frac{1}{4}$ in. on the top face, as indicated in Fig. 3. With the double quadrant method of rest adjustment, correct setting of the tool is easy. The double-wheel grinding and lapping machine, which is illustrated in Fig. 1, in addition to being equipped with the double quadrant arrangement, has the advantage that the tool may be brought into contact with either side of either the grinding or the lapping wheel without interfering with its setting in the tool holder. This machine may also be used for grinding thread-cutting and other form tools to a true radius, and for producing teeth of uniform angle, diameter and parallelism on milling cutters with sintered-carbide tips. Various attachments to universal tool-grinding machines are available for these latter operations, but it is frequently necessary to equip such machines with special diamond wheels and care has to be taken regarding wheel size and speed.

The main feature of the machine which is illustrated in Fig. 1, and is manufactured by Messrs. W. G. Bowen and Company (Engineers), Limited, 6, Broad Street-place, London, E.C.2, is that it is equipped with two grinding or lapping wheels, arranged side by side and driven by a common motor. The spindles run in adjustable plain and antifriction bearings. One of the spindles, usually that which runs at the higher speed, is driven directly from the motor through a flexible coupling, the other being driven by Vee belt. The tool saddle slides on two large-diameter ground cylindrical bars and the tool may be brought into contact with the face or rim of either wheel, giving four grinding positions. The bars on which the saddle slides are protected from the abrasive by sheet-metal covers. The handle seen to the left in Fig. 1 is used for oscillating the tool across the face of the wheel in lapping operations. The tool rest can be clamped as desired in two planes at right angles, and can be rotated on a vertical axis by means of a circular table on the saddle (see Fig. 2), while the distance from the wheel face can be varied by means of a cross slide, and can also be adjusted by the position of the upper table. The wheels are protected by removable guards having a water tank to moisten a felt pad pressed against the wheel surface. Diamond wheels require very little coolant. The machine illustrated in Fig. 1 is of the bench type, but it is also built for floor mounting. Special attachments are provided for grinding and lapping milling cutters, cutting through pieces of sintered carbide and similar hard materials, grinding chip-breaking grooves, etc.

THE MANUFACTURE OF CORRUGATED-STEEL CULVERTS.

The culvert, partaking of the characteristics of both tunnel and bridge, is, perhaps, more widely used abroad than in this country for taking water courses under road and railway embankments and in similar situations in which the volume of water passing or the absence of traffic on that water does not call for a bridge. It is certainly employed largely in the United States, in which country a form constructed of curved corrugated steel sheets has enjoyed considerable favour. Figs. 1 to 4, on page 438, show the manufacture of this type of culvert by Messrs. Republic Steel Corporation, Canton, Ohio, U.S.A. Two machines only are employed for the complete fabrication, these being two forms of crank-operated press, known as the Cincinnati press brake and made by Messrs. The Cincinnati Shaper Company, Cincinnati, Ohio, U.S.A. The first operation, which consists of the simultaneous corrugation of flat sheets and the punching of the holes for the connecting bolts, is carried out in the press shown in Fig. 1. While, in the main, this machine is of the firm's standard type, it is fitted with the automatic feeding table seen to the right of the illustration. The sheets naturally vary in length, width and thickness according to the diameter of culvert required, the maximum thickness being $\frac{5}{32}$ in. The thickness, however, is not limited by the capacity of the press, which can be constructed with sufficient power to bend 12 ft. of 1-in. thick plate, or 18 ft. of $\frac{3}{8}$-in. thick plate through a right-angle.

The plates are punched along their long edges, which form the longitudinal seams of the culvert, in both the crests and valleys of the corrugations, and along their short edges, the circumferential seams of the culvert. Means are provided for readily engaging the punches as required, so that the holes referred to above can be made while the plate is going through the press. The flat sheet is first pushed in by hand until its end comes into contact with the pressure bar of the press ram. This determines the position of the first corrugation, which is made by the descent of the ram. After this first stroke, the plate is fed forward automatically and the remaining corrugations are formed. The corrugated sheets are stacked on skids by an ingenious device. Two loaded skids are seen in Fig. 2 in the background of which illustration the corrugating press is visible.

The loaded skids are then transferred by a crane to another press, which gives them the requisite segmental curvature, as shown in Fig. 3. This view shows part of a culvert tacked together in order to demonstrate the accuracy of the manufacturing operations. The actual assembly of a culvert is done in the field, the curved plates being transported to the site. The curving of the plate is done in a somewhat lighter type of press and this operation is clearly shown in Fig. 4. Any desired radius can be formed by appropriate adjustment of the die blocks, the shape of which will be evident in Fig. 4. It is stated that this method of fabrication has proved both satisfactory and economical. The corrugations are uniform, as also is the radius of the segments, so that rapid assembly is facilitated, while the actual operations of manufacture are reduced to the minimum. The makers of the Cincinnati press are represented in Great Britain by Messrs. E. H. Jones (Machine Tools), Limited, Edgware-road, The Hyde, London, N.W.9.

MOONLIGHT CALENDAR FOR 1940.—Messrs. The Rawlplug Company, Limited, Rawlplug House, Cromwell-road, London, S.W.7, have sent us a copy of their "Moonlight Calendar" for 1940. This consists of monthly charts on which black, shaded, and white squares indicate the hours of darkness, and of dim and bright moonlight for each night in the month.

THE LATE MR. W. S. EVERY.—It is with regret that we have learnt of the death of Mr. William Stephen Every, which took place at 4, Vanbrugh-road, Bedford Park, London, W.4, on April 12. Mr. Every, who was signal engineer to the London Passenger Transport Board, was born in 1875, and entered the service of the Underground Railways in 1905 as an inspector on the installation of signalling. In 1921 he was appointed signal engineer and an officer of the Company. He became signal engineer of the Board upon its establishment in 1933, and, in 1939, was made a principal officer. Mr. Every, who was a past-president of the Institution of Railway Signal Engineers, had been responsible for the design and installation of the whole of the signalling under the Board's programme of new works and extensions.

DRAFT SPECIFICATION OF ENGINEERS' SQUARES.

The British Standards Institution has prepared, under the authority of its Mechanical Industry Committee, and in response to a request made by the Institution of Production Engineers, a draft standard specification for the engineer's steel square, commonly known as a try-square. Copies of this draft specification, which should not in the meantime be accepted as a standard, have been circulated to manufacturers concerned, but other individuals and organisations may have constructive comment to make. Any persons thus interested can obtain a copy of the specification, No. CF (ME) 5599, on application to the British Standards Institution, 28, Victoria-street, London, S.W.1, and should send in their observations thereon before June 4, 1940.

In order to give some idea of the proposals contained in the draft specification, we give a short summary of it below. Three grades of accuracy are suggested, the highest grade, consisting of squares for reference purposes, where very precise accuracy is essential. The maximum length of blade for this grade is proposed to be 12 in., measured from the tip to the inside of the stock. Six sizes below this, down to 2 in., are proposed, and the edges of the blade are to be bevelled to a width varying from 0·01 in. to 0·025 in., according to the length, in order to ensure more accurate reading should the square be not held precisely normal to the work. The maximum error from straightness of the blade and stock shall not exceed ±0·00005 in. in the smaller sizes and 0·00008 in. in the larger sizes, these amounts being the departure above or below a mean true line, *i.e.*, the crests and hollows of any "waves" on the surfaces. The blade and stock must have their respective edges parallel to within 0·0001 in. or to within 0·00015 in., according to size. When the square is stood upright on a horizontal surface, the maximum departure from a vertical surface, measured at the tip of the blade, shall not exceed an amount varying from 0·0001 in. to 0·00025 in., according to size, this figure indicating the permissible departure from true squareness. Other limits are given for error in lateral squareness, *i.e.*, sideways inclination of the blade to the stock and for the squareness of the side faces of the stock to its working faces. The degree of rigidity of the square is defined by holding the stock rigid and applying a force of 1 lb. to the tip of the blade in a direction parallel to the length of the stock. The resultant deflection must not exceed the permissible amounts of departure from true squareness.

The second grade of square is proposed for inspection purposes or for use in tool rooms and workshops where a good degree of accuracy is necessary. The sizes recommended are nine in number, ranging from 2 in. to 24 in. length of blade. The permissible errors are, speaking generally, roughly double those of the reference squares. The third grade is proposed for general workshop use and the same sizes as for the inspection grade are recommended. The permissible errors are, again speaking generally, roughly twice as great as those allowed for the inspection squares. No suggestions are made regarding general dimensions, other than lengths of blades, of any of the grades. The material of all squares shall be good quality steel. The reference and inspection squares shall have the working edges of the blade and the working faces of the stock hardened to a diamond-pyramid hardness number of not less than 600, *i.e.*, approximately 54 on the Rockwell C. scale. These edges and faces on the reference squares shall be finished by lapping. The other surfaces on these squares, and all surfaces of the inspection and workshop squares, are to be finished by grinding. All sharp edges are to be removed. The stocks of all squares are to be of greater thickness than the blades, and are to be constructed with a notch at the junction of the inner edge of the blade with the upper face of the stock so that the inner corner of the square will seat freely on sharp-cornered work.

The draft specification contains recommendations for protective cases, packing and marking, and has two appendices. One of these deals with the construction of the bevelled edges of the reference square blades and the other on methods of testing squares, and on the design of try-squares and block squares. The specification has adequate explanatory illustrations.

The Centenary of Postage Stamps.—In connection with the centenary of the first issue of postage stamps, which falls on May 6, the Royal Society of Arts has arranged two meetings, to be held on the Wednesday afternoons immediately preceding and succeeding the centenary. On Wednesday, May 1, at 2.30 p.m., Mr. Samuel Graveson, honorary treasurer of the Postal History Society, will read a paper on the "Uniform Penny Post," and, on May 8, Mr. Guy Harrison, of Messrs. Harrison and Sons, Limited, will speak on "The Postage Stamp." It is hoped to arrange for small displays in connection with each of these meetings.

TENDERS.

We have received from the Department of Overseas Trade, Great George-street, London, S.W.1, particulars of the undermentioned tenders, the closing dates of which are as stated. Details may be obtained on application to the Department at the above address, quoting the reference numbers given.

Lead Sheet, Plumbers' Metal and Solder. Union Tender and Supplies Board, Pretoria; May 16. (T. 18,483/40.)

Railway Rolling-Stock Equipment, including bogie parts, axleboxes and screw-coupling parts. Indian Stores Department, Engineering Section, New Delhi; May 15. (T. 18,494/40.)

Water Meters to conform to I.S.D. specification No. G.W.W. 54A. Indian Stores Department, Hardware Section, New Delhi; May 6. (T. 18,495/40.)

Marine Diesel Engines, two, 100-h.p., for propelling two motor launches. Also *Marine-Type Boiler* capable of evaporating 500 kg. (1,100 lb.) of water per hour and working at 7 kg. per sq. cm. (100 lb. per sq. in.). Mechanical and Electrical Department, Ministry of Public Works, Cairo, Egypt; May 14. (T. 18,553/40.)

Lead Rolling Mill. Posts and Telegraphs Department, Melbourne, Australia; April 30. (T. 17,070/40.)

Power-Station Plant, comprising two vertical-type, 90-b.h.p. Diesel engines directly-coupled to two three-phase, 50-cycle, 75-kVA alternators having a voltage of 3,150 between phases, for El Arish Central Station. Ministry of Public Health, Municipalities Department, Cairo, Egypt; May 18. (T. 18,544/40.)

Buffers for the East Indian Railway. Indian Stores Department, Engineering Section, New Delhi; May 15. (T. 18,642/40.)

Steel Axles, 28, finished 7 in. by 4 in., and *Tyred Disc Wheels*, 8 sets, 28½ in., by 7 in. by 4 in., for the Jodhpur Railway. Indian Stores Department, Engineering Section, New Delhi; May 13. (T. 18,643/40.)

Air-Compressor, electric-motor driven, having a piston displacement of 430 cub. ft. per minute, for installation at the Faculty of Science, Giji. Ministry of Public Works, Mechanical and Electrical Department, Cairo, Egypt; May 18. (T. 18,680/40.)

Switchgear, two sets, 11-kV, indoor, metal-clad, draw-out type, having a breaking capacity of 150 MVA. One set for Gore Substation (T. 18,688/40), and the other for Winton Substation (T. 18,691/40). Public Works Department, Wellington, N.Z.; May 14.

Traffic Signs, fourteen different types. Corporation of Durban, Natal, South Africa; May 17. (T. 18,758/40.)

BOOKS RECEIVED.

Steam Conquers the Pacific. A Record of Maritime Achievement, 1840-1940. By A. C. Wardle. London: Hodder and Stoughton. [Price 10*s.* 6*d.* net.]

British Non-Ferrous Metals Research Association. Research Reports. No. 524. *Quantitative Spectrographic Analysis with the Microphotometer.* Part I. *A Review of Published Work.* By D. M. Smith. Euston-road, London, N.W.1: Offices of the Association. [Price 2*s.*]

Indian Forest Records (New Series). Utilisation. Volume I. No. 8. *Notes on the Air Seasoning Characteristics of Some Indian Woods.* By Dr. S. N. Kapur and M. A. Rehman. Delhi: Manager of Publications. [Price 8 annas, or 9*d.*]

Design and Construction of Air-Raid Shelters, in Accordance with the Civil Defence Act, 1939, *and for "Unspecified" Areas and Other Purposes.* With designs and notes by D. H. Lee. London: Concrete Publications, Limited. [Price 8*s.* 6*d.* net.]

Department of Scientific and Industrial Research. Fuel Research. Physical and Chemical Survey of the National Coal Resources. No. 49. *The Cumberland Coalfield. The Six-Quarters Seam.* London: H.M. Stationery Office. [Price 2*s.* net.]

Aircraft Identification. Friend or Foe? Third edition. By the Staff of "The Aeroplane." London: Temple Press Ltd. [Price 1*s.* 6*d.* net.]

Advanced Calculus. By Professor I. S. Sokolnikoff. London: McGraw-Hill Publishing Co., Ltd. [Price 26*s.*]

Principles of Industrial Organisation. By Professor D. S. Kimball and D. S. Kimball, Junr. Fifth edition. London: McGraw-Hill Publishing Co., Ltd. [Price 26*s.*]

Industrial Plastics. By H. R. Simonds. London: Sir Isaac Pitman and Sons, Ltd. [Price 22*s.* 6*d.* net.]

First Year Engineering Science. Mechanical and Electrical. Third edition. By G. W. Bird. Revised by B. J. Tams. London: Sir Isaac Pitman and Sons, Ltd. [Price 5*s.* net.]

Plane and Geodetic Surveying for Engineers. By the late Professor David Clark. Volume I. *Plane Surveying.* Third edition, revised and enlarged. By James Clendinning. London: Constable and Co., Ltd. [Price 27*s.* 6*d.* net.]

PERSONAL.

Mr. Frank Gill, O.B.E., has been elected chairman of the Telephone Development Association for the current year.

Acting under the provisions of Section 1 of the London Passenger Transport Act, 1933, the Appointing Trustees have re-appointed Lord Ashfield to be chairman of the London Passenger Transport Board, 55, Broadway, London, S.W.1, for a further period of seven years from May 18, 1940. The Trustees, moreover, have considered the vacancy on the Board created by the decision of the vice-chairman, Mr. Frank Pick, to retire on May 18, but have decided that the question of filling this vacancy should stand adjourned for the present.

Mr. H. T. Tilley has been appointed manager of the London Engineering Department of Messrs. The General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, in succession to the late Mr. J. Mercer. Mr. Tilley joined the Department in 1910 and has been principal assistant to Mr. Mercer for the past 15 years.

Mr. A. J. Grainger has been appointed sales manager, Engineering Division, of Messrs. British Timken, Limited, Cheston-road, Aston, Birmingham.

Mr. G. B. Blaker has been appointed private secretary to the Secretary of the Department of Overseas Trade, Mr. Geoffrey Shakespeare, for Department of Overseas Trade duties.

Mr. J. F. C. Morden, B.Sc., has been appointed assistant metallurgist to Messrs. Standard Motors (Aero Engines), Limited, Coventry.

Mr. Robert Armitage, who became a director of Messrs. Brown Bayley's Steel Works, Limited, Sheffield, in 1890, and chairman in 1895, has resigned his position as managing director while continuing to act as chairman. His son, Mr. E. H. Armitage, is succeeding him as managing director.

Mr. A. A. B. Martin has been elected chairman of the Dundee Sub-Centre of the Institution of Electrical Engineers for 1940-41.

Messrs. Commercial X-Rays, Limited, have established a branch, complete with laboratories and offices, at 53, Wentworth-road, Harborne, Birmingham, 17.

Messrs. Vickers Limited, Vickers House, Broadway, London, S.W.1, inform us that Sir Charles Craven has been granted leave of absence from the Vickers Group of Companies to take up a Government appointment of national importance. In consequence, Mr. F. C. Yapp has been appointed acting chairman of Messrs. Vickers-Armstrongs Limited, and of the English Steel Corporation Limited, and Mr. J. Callander has been made acting deputy chairman of Messrs. Vickers-Armstrongs Limited.

Dr. Stanley B. Bagley, F.S.G.T., was elected President of the Society of Glass Technology in succession to Dr. C. J. Peddle, M.B.E., F.S.G.T., at the 23rd annual general meeting of the Society, held in Sheffield, on Wednesday, April 17.

Mr. E. Bruce Ball, M.I.Mech.E., a past-president of the Institution of Mechanical Engineers, has been elected a Fellow of the Royal Society of Edinburgh.

Professor Andrew Robertson, D.Sc., Wh.Ex., M.I.Mech.E., and Professor Gilbert Cook, D.Sc., M.I.Mech.E., have been elected Fellows of the Royal Society.

NOTES FROM THE SOUTH-WEST.

Cardiff, Wednesday.

Welsh Coal Trade.—There was a brisk demand circulating on the Welsh steam-coal market for all grades, but almost the whole of the collieries' present outputs were earmarked for deliveries to be made on account of existing contract commitments. Order books were sufficiently well filled to ensure the steady absorption of almost the whole potential outputs over a long time ahead and the general tone remained very firm. Lord Portal, who has been appointed head of the Coal Production Council, set up by the Government to find ways and means of increasing the country's coal output by 30,000,000 tons annually, visited Cardiff during the week and discussed the matter with the Coal Trade Conciliation Board of Monmouthshire and South Wales. Both owners and miners expressed their desire to co-operate in the efforts being made and a joint committee was formed by the Board to co-operate with Lord Portal's Committee. The popular duff coals remained in brisk request, but producers had already disposed of practically the whole of their potential outputs over several months ahead and the occasional parcels of these kinds which became available were taken up at high figures. Cokes were in active demand and patent fuel again displayed activity.

The Iron and Steel Trade.—In the iron and steel and allied trades of South Wales and Monmouthshire activity was well maintained last week. The demand for the various finished products was sustained, and as most works were sufficiently well placed with orders to ensure their employment to almost full capacity for some while ahead, the general tone was strong.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Like many other sections of local industry, those branches devoted to the production of steelworks' and ironworks' machinery have made remarkable progress during the past six months. Not only are works extensions numerous in this area, but Sheffield is supplying machinery and equipment for extension schemes in other parts of the country. Contracts vary from heavy rolling mills and forging presses to lathes capable of turning out high-precision work. Sheffield is producing large quantities of drop stampings made of high-quality alloy steels for heavily-stressed parts in internal-combustion engines. Electrical power development schemes in various parts of the country are requiring hollow forgings and boiler drums of record size and weight, and orders are also on hand from abroad. The demand by foreign mining enterprises for Sheffield-made grinding and crushing machinery, precious-metal washing plant, and dredging equipment has been well maintained. British coal owners are ordering with more freedom, and among the specifications are pneumatic drills, coal-cutting machines, winding and haulage gear, and steel pit tubs. Efforts now being made to increase coal output are likely to result in greater mechanisation, and Sheffield makers of colliery equipment should benefit considerably. The call for agricultural machinery and parts is brisk; inland needs show a considerable improvement, while the Dominions and Colonies are taking increased supplies. Extra shifts are being worked at many firms. An active demand is reported for raw and semi-finished steels, and buying has shown a steady rise for some time, with the result that record outputs at many works have been attained. Basic billets and acid steel are in strong request.

South Yorkshire Coal Trade.—In many classes of coal buying is in excess of the seasonal level; this applies particularly to house coal. Heavy tonnages are going to the south of England, and merchants report that householders are laying in stocks in readiness for next winter. The industrial demand for coal is also heavy, but transport is operating smoothly and few complaints of shortage are reported. Steam coal is in strong demand, and small coal, slack and coke find a ready market.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—In the Scottish steel trade conditions have not changed to any extent and the demand is very constant. With distribution now controlled, supplies of steel are being equally apportioned according to the class of work being done. The requirements of the shipbuilding industry are large and every consideration is being given to the demand for ship plates, etc. There is a large amount of structural work going on at present and sectional material is in strong request. Sheet makers have also very well filled order books and a large proportion of the present output is for Government contracts. The raw-material position is satisfactory, deliveries of steel scrap having been good. The following are the present prices:—Boiler plates, 13*l.* 8*s.* per ton; ship plates, 12*l.* 10*s.* 6*d.* per ton; sections, 12*l.* 8*s.* per ton; medium plates, under $\frac{3}{16}$ in. thick, weighing 6 lb. or more per square foot, 14*l.* per ton; weighing under 6 lb. but not less than 4·81 lb. per square foot, 14*l.* 10*s.* per ton; black-steel sheets, No. 24 gauge, in 4-ton lots, 17*l.* 10*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, in 4-ton lots, 20*l* per ton, all delivered at Glasgow stations.

Malleable-Iron Trade.—The malleable-iron trade of the West of Scotland is carrying on steadily, and the position at the moment is satisfactory. The re-rollers of steel bars are well placed for supplies of semi-manufactured steel, as large consignments have recently arrived in port and there are prospects of fairly regular deliveries coming forward. They have a large amount of work on hand and are operating to capacity. Prices are unchanged except for "Crown" bars, which have been advanced by 25*s.* per ton. The current quotations are as follows:—Crown bars, 14*l.* 2*s.* 6*d.* per ton; No. 3 bars, 12*l.* 10*s.* per ton; No. 4 bars, 12*l.* 15*s.* per ton; and re-rolled steel bars (tested), 14*l.* 3*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—The steady output of Scottish pig-iron from the furnaces in blast continues and the position with regard to raw materials is satisfactory. There are good stocks of iron ore and supplies are coming forward. To-day's market quotations are as follows:—Hematite, 6*l.* 7*s.* 6*d.* per ton, and basic iron, 5*l.* 4*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 5*l.* 15*s.* 6*d.* per ton, and No. 3, 5*l.* 12*s.* 6*d.* per ton, both on trucks at makers' yards.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Mr. C. R. Bashford, of the Round Oak Steel Works, Limited, Brierley Hill, Staffs, has been re-elected President of the Staffordshire Iron and Steel Institute.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—The usual buyers of iron and steel have substantial orders to place, but general commercial transactions continue on a very limited scale. Rather better deliveries of iron and steel scrap are very welcome. Plans are well advanced for the control of steel distribution.

Cleveland Iron Trade.—The production of numbered qualities of Cleveland pig iron is still suspended and the small, intermittent make of substitute products contributes little to the needs of local founders who, however, continue to receive tonnage from the Midlands which is sufficient for requirements. Merchants are handling only very moderate lots of iron. The fixed prices of Cleveland pig are ruled by No. 3 description at 111*s.*, delivered within the Tees-side zone.

Hematite.—The delivery demands for East Coast hematite are taxing the resources of the makers and the well maintained heavy output is passing promptly into use. Buyers are taking full supplies under extensive running contracts and the requirements of makers' own consuming departments are increasing. As the demand is likely to expand further, an enlargement of output cannot long be delayed and preparations for this are proceeding. Hematite producers are confident of their ability to supply all requirements for actual consumption. Quotations remain at the level of No. 1 grade of iron at 127*s.* 6*d.*, delivered to North of England areas.

Basic Iron.—Basic-iron makers are turning out a large tonnage, the whole of which is required for use at their own steelworks. The quotation remains nominal at 104*s.* 6*d.*

Foreign Ore.—Consumers of foreign ore have a good deal of material on hand and are receiving adequate supplies.

Blast-Furnace Coke.—Transactions in Durham blast-furnace coke are few, since local users have almost provided for their requirements and holders have sold as extensively as they care to. Market values are based on good medium qualities at 31*s.* 8*d.* at the ovens.

Manufactured Iron and Steel.—The considerable make of semi-finished iron and steel, supplemented by substantial imports of Continental semies, provides re-rollers with sufficient material to enable them to turn out heavy tonnages. Finished-iron firms are busy and have a great deal of work to carry out. Producers of finished steel are continuing to operate their plant at full capacity in order to meet requirements.

Scrap.—Deliveries of iron and steel scrap have improved appreciably. The descriptions for which there is most call are heavy steel and the better qualities of cast iron.

MESSRS. BRITISH TIMKEN, LIMITED.—We are informed that the name "Timken" has recently been registered as the trade mark of Messrs. British Timken, Limited, Cheston-road, Aston, Birmingham. The Company has used the name as a trade mark for many years, and the formalities of official registration have now been completed.

RADIO STATION FOR ELECTRICITY SUPPLY MAINTENANCE.—According to the *Electrical World*, preliminary tests are being made of a 250-watt radio station which has been built by the Kansas City Power and Light Company to assist in restoring the supply in cases of emergency. This station, which is designed for 39,660 kilocycles per second, is erected on the thirty-first floor of the company's building and will enable communication to be established with ten cars and lorries belonging to the operating department. In this way it is hoped that time will be saved by crews who wish to report to or receive orders from headquarters before leaving the scene of the emergency.

MACHINE-SHOP EQUIPMENT.—A catalogue of unusual completeness entitled "Small Tools and Machine-Shop Accessories," has just been published by Messrs. Alfred Herbert, Limited, Coventry, and its 610 pages should form a useful reference book for those responsible for the maintenance of a machine shop, as far as small equipment is concerned. Milling, boring, turning and drilling tools in great variety are dealt with as well as the dieheads and other screwing gear with which the firm has long been identified; many other tools and accessories illustrate the range of its activities. The section dealing with portable electric tools is comprehensive and comprises, drills, grinders, hammers, shears, saws, screwdrivers, nut-runners, tappers, stud-setters, valve refacers, and so forth. Gauges and other measuring devices are also fully dealt with, the range including dial gauges, precision blocks, micrometers, optimeters, comparators, optical flats, toolmakers' microscopes, etc. Ardoloy drawing dies, tilting machine-tool tables, friction clutches and vices of various sorts illustrate the type of accessory listed in other sections. The catalogue, which is distinguished as "Number Twelve," is fully illustrated.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—*Internal Combustion Engine Group:* To-night, 6 p.m., Storey's-gate, Westminster, S.W.1. Extra General Meeting. "Fuel Injection in Oil Engines in Relation to Combustion," by Mr. G. W. A. Green. Friday, May 3, 6.30 p.m. Informal Discussion on "Operating Experience with Gas Producers."

JUNIOR INSTITUTION OF ENGINEERS.—To-night, 6.30 p.m., 39, Victoria-street, Westminster, S.W.1. Informal Meeting. Lecture: "The Construction of High Level Huts in the Alps," by Mr. R. P. Mears.

ROYAL INSTITUTION.—To-night, 9 p.m., 21, Albemarle-street, W.1. "Geophysical Study of Submarine Geology," by Dr. E. C. Bullard. Wednesday, May 1, 5 p.m., Annual Meeting.

ROYAL SANITARY INSTITUTE.—Saturday, April 27, 10 a.m., The City Museum, Leeds. Discussions: (i) "The Garchey System of Refuse Disposal," to be opened by Professor J. J. Jervis. (ii) "Modern Flat Building," to be opened by Mr. R. A. H. Livett.

PHYSICAL SOCIETY.—Monday, April 29, 3 p.m., The Cavendish Laboratory, Cambridge. Discussion on "The Liquid State," to be opened by Professor J. E. Lennard-Jones. Supporting papers will include: (i) "Viscosity in the Liquid State," by Professor E. N. da C. Andrade. (ii) "Observations on the Parachor," by Professor Allan Ferguson. (iii) "The Atomic Distribution Function of a Simple Liquid Model," by Mr. J. Corner. (iv) "The Potential Energy Function," by Professor J. D. Bernal.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, May 1, 4.30 p.m., 49, Cromwell-road, South Kensington, S.W.7. "Report on the Phenological Observations in the British Isles, from December, 1938, to November, 1939," by Major H. C. Gunton.

INSTITUTION OF ELECTRICAL ENGINEERS.—*Wireless Section:* Wednesday, May 1, 6 p.m., Savoy-place, Victoria-embankment, W.C.2. "Civil Air Transport Communication," by Mr. A. D. Hodgson. *Meter and Instrument Section:* Friday, May 3, 6 p.m., Savoy-place, Victoria-embankment, W.C.2. Lecture on "Insulation," by Mr. H. Warren.

IRON AND STEEL INSTITUTE.—Thursday, May 2, and Friday, May 3, 4, Grosvenor-gardens, Westminster, S.W.1. Seventieth Annual General Meeting. Thursday, May 2, 10 a.m. Presidential Address by Mr. John Craig and various papers for discussion. 2.30 p.m., Presentation of various papers. Friday, May 3, 10 a.m., Presentation of various papers. 1 p.m., Grosvenor House, Park-lane, W.1. Members' Luncheon. For programme, see page 366 *ante*.

ALTERNATIVE FUELS FOR MOTOR VEHICLES.—At a recent meeting of the Committee of Management of the British Road Federation it was unanimously decided that a special Fuels Committee, representing all sections of the road-transport industry and embodying the Fuels Committee appointed last January by the Associates' Committee, should be set up to consider all aspects of the problem relating to the use of fuels for motor vehicles, including the use of alternative fuels. Following consultation with the British Road Federation, the chairman of the Government committee on the use of home-produced fuels in internal-combustion engines has asked the Federation for its views on the use and costs of home-produced fuels in these engines.

W. E. HIGHFIELD SHIELD COMPETITION, 1940.—The Association of Supervising Electrical Engineers, Aldwych House, London, W.C.2, informs us that the 17th annual competition for the W. E. Highfield Shield will take place this year. In addition to the Shield, there will be cash prizes ranging from 2*l.* 2*s.* to 5*l.* 5*s.*, and the member winning the first prize will be the holder of the Shield for one year, his name will be inscribed thereon, and he will receive a replica as part of his prize. Candidates must submit a paper not exceeding 2,000 words and dealing with the electrical industry and/or the Association. A signed declaration that the paper is the unaided work of the competitor must accompany each paper, which must reach the general secretary of the Association, from whom further particulars may be obtained, not later than noon on Tuesday, October 8, next. It is expected that the decision of the examining board will be announced in time for the presentation of the Shield and prizes at the lecture meeting on December 17. The literary style of the papers (we note with some regret) is stated to be of minor importance, as the competition is "to encourage papers of a practical nature and original thought." Provincial members, associate members and associates are specially invited to compete. Associates will compete in their own section.

PRESS FOR THE MANUFACTURE OF CORRUGATED STEEL CULVERTS.

MESSRS. THE CINCINNATI SHAPER COMPANY, CINCINNATI, OHIO, U.S.A.

(*For Description, see Page* 435.)

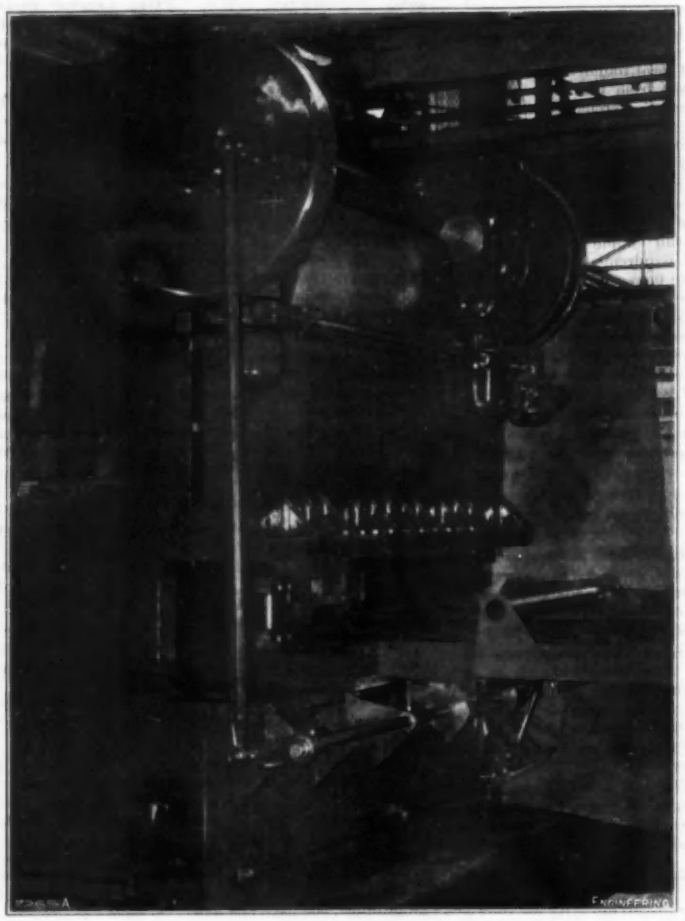


Fig. 1. Corrugating and Punching Press.

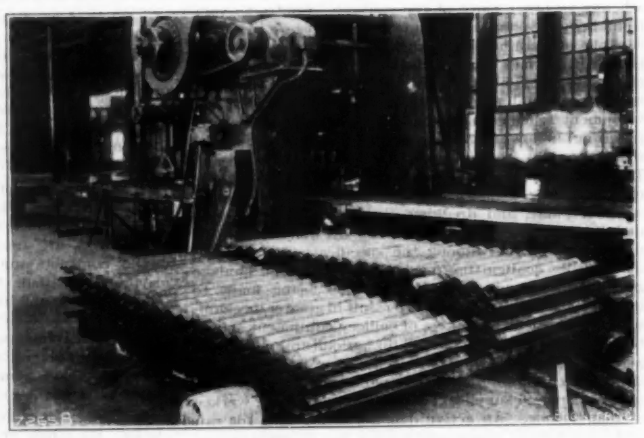


Fig. 2. Corrugated and Punched Sheets.

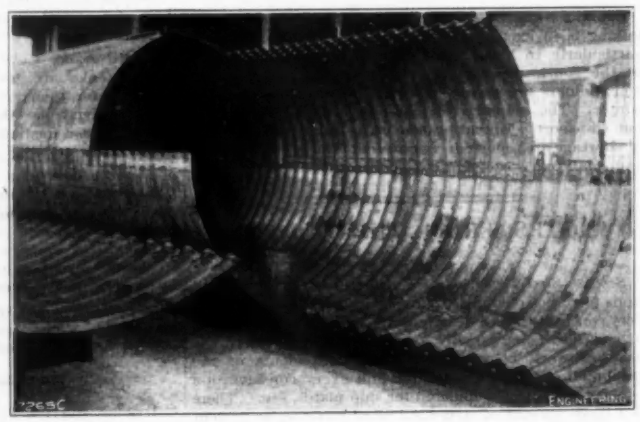


Fig. 3. Partly-Assembled Corrugated Culvert.

THE MACROME PROCESS FOR TOOL STEELS.

We have referred on several occasions in our columns to the Macrome toughening treatment for high-speed and carbon-steel cutting tools and, although no technical information regarding the process is available for publication, test reports issued from time to time by the firm, Messrs. Macrome, Limited, Hay Mills, Birmingham, appear to substantiate the claim that the treatment considerably increases the average life of tools when compared with that of untreated tools of similar quality. As is well known, the process is applied to cutting tools, such as twist drills, taps, reamers, milling cutters, hacksaws, slitting saws, screwing dies and tool bits, after the final heat treatment, and the effect of the process, it is stated, is to toughen the tool throughout so that it is better able to withstand the stresses to which it is subjected in service. Two reports of comparative tests recently carried out, one in a large shipbuilding yard and the other in an aeroplane factory, have now been issued. In the shipyard test, holes were drilled in steel, $\frac{7}{16}$ in. in thickness, and it was found that three $\frac{13}{16}$-in. high-speed steel twist drills could make 450 holes before becoming "badly worn." On the other hand, it is claimed that two exactly similar twist drills, after being subjected to the Macrome treatment, were able to make 3,600 holes in the same steel before requiring grinding. The tests at the aeroplane factory gave a comparison between the performances of treated and untreated screwing dies. It is stated that, with the latter, the normal output is 1,000 components per re-grind but that upwards of 7,000 components were threaded with a treated set of dies before re-grinding. Union screwing taps, after undergoing the Macrome treatment, ran for from 42 days to 57 days without attention, compared with 2 days to 3 days for untreated taps.

Fig. 4. Bending Corrugated and Punched Sheets to Radius.

TELEGRAM-FORM CONVEYING SYSTEMS: GENERAL POST OFFICE.

COLONEL A. S. ANGWIN, D.S.O., M.C., M.I.E.E., ENGINEER-IN-CHIEF.

(*For Description, see Page* 429.)

Fig. 12. Segregation Table Drag-Band Conveyor.

Fig. 13. Drag-Band and Floor Vee-Conveyors.

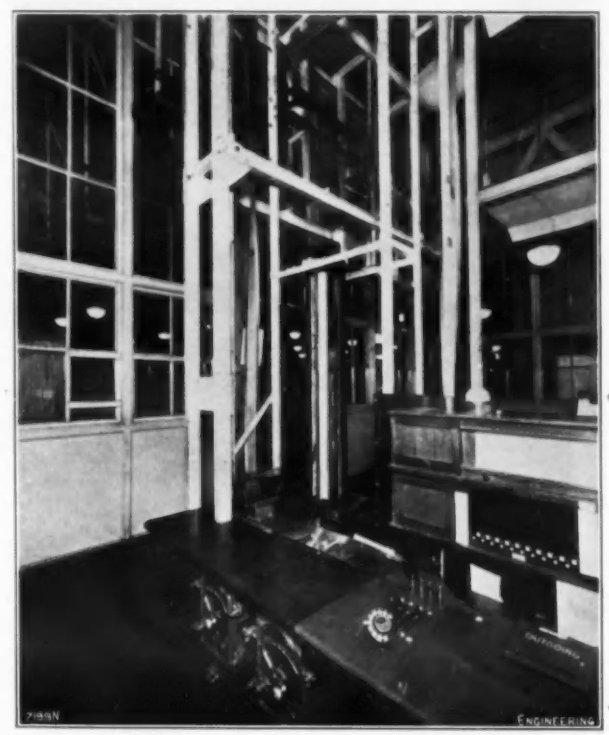
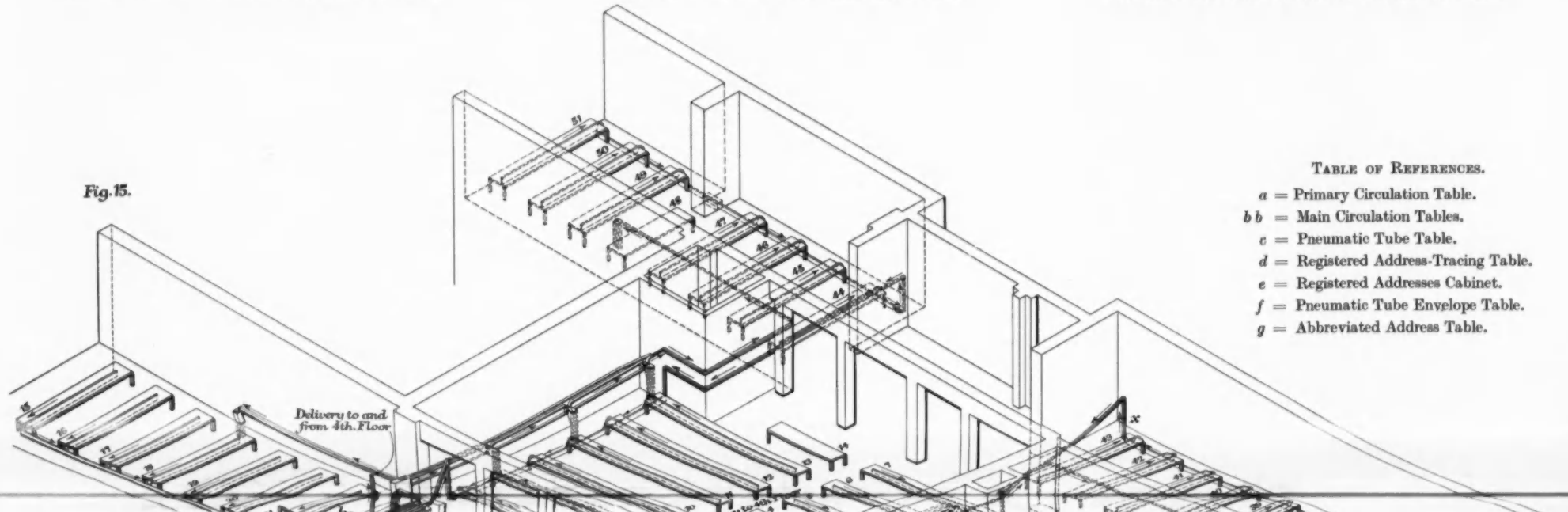


Fig. 14. Drag-Band Conveyors. Phonogram Table.

Fig.15.



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- *a* = Primary Circulation Table.
- *b b* = Main Circulation Tables.
- *c* = Pneumatic Tube Table.
- *d* = Registered Address-Tracing Table.
- *e* = Registered Addresses Cabinet.
- *f* = Pneumatic Tube Envelope Table.
- *g* = Abbreviated Address Table.

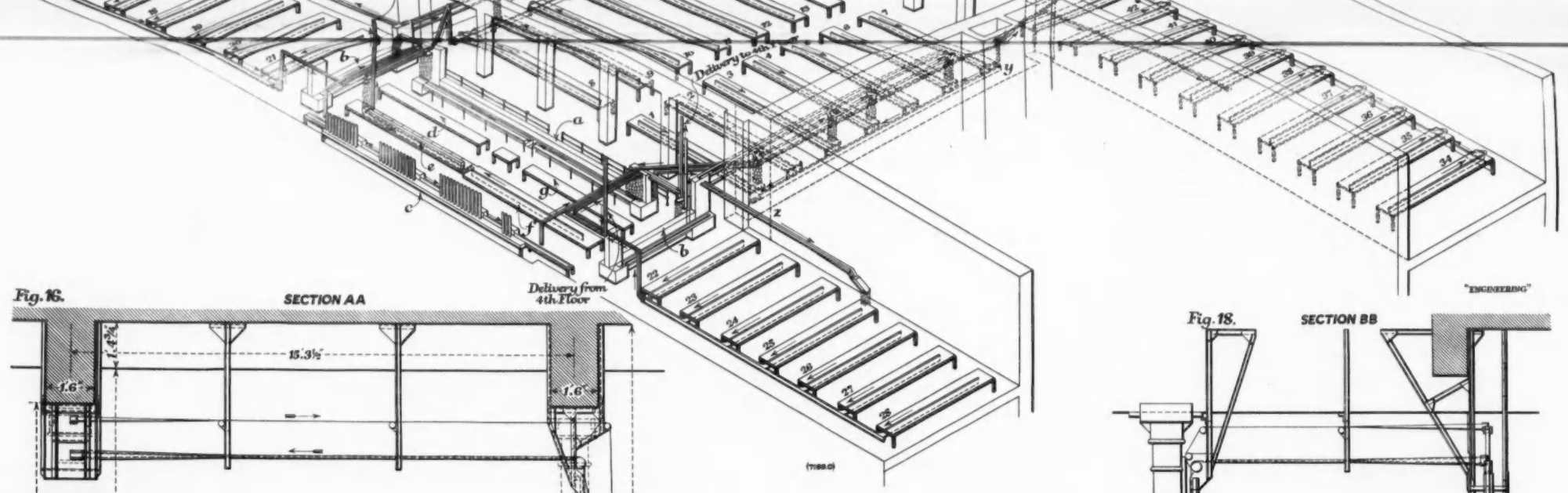


Fig. 16.

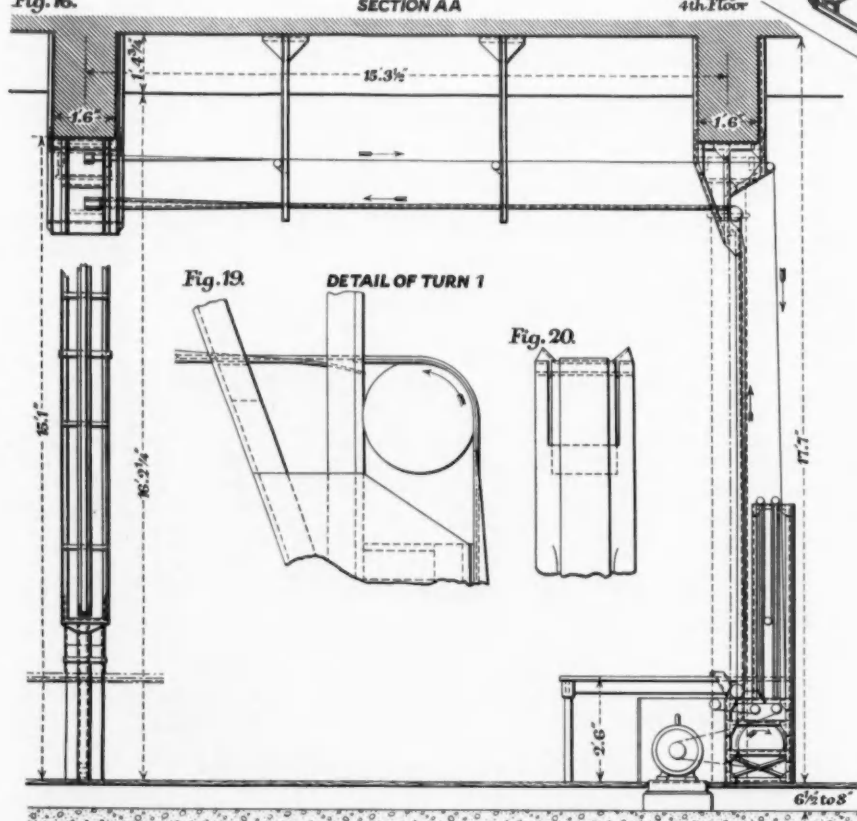


Fig. 17.

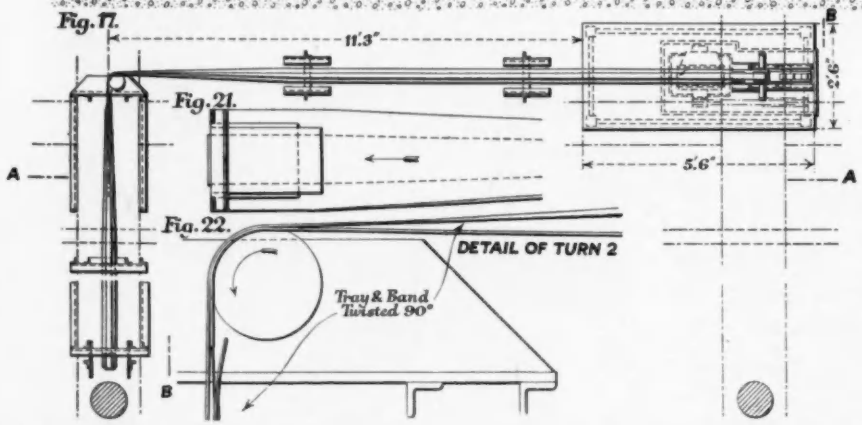


Fig. 18.

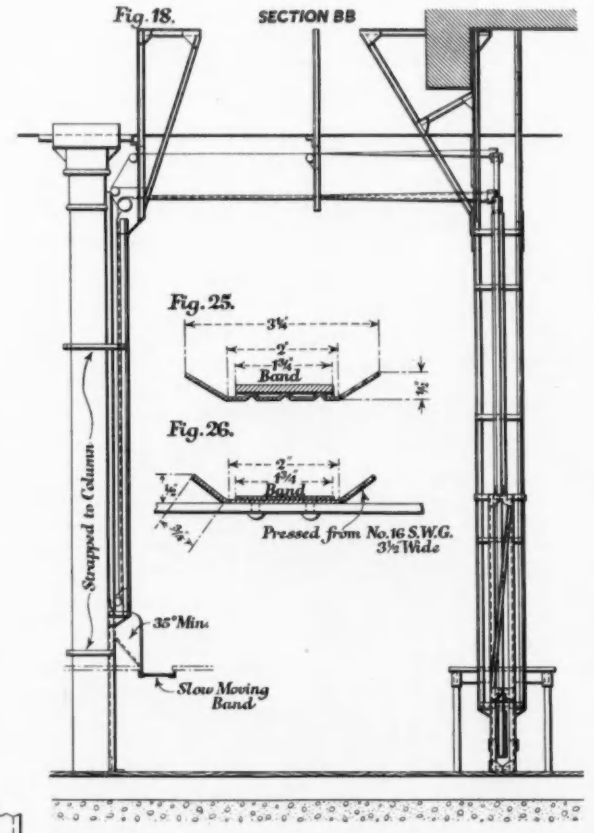


Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

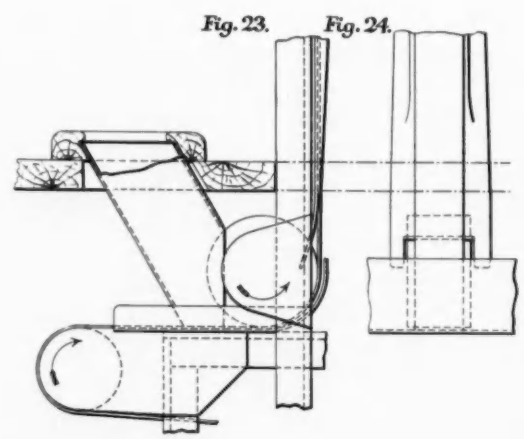


Fig. 25.

Fig. 26.

Fig. 27.

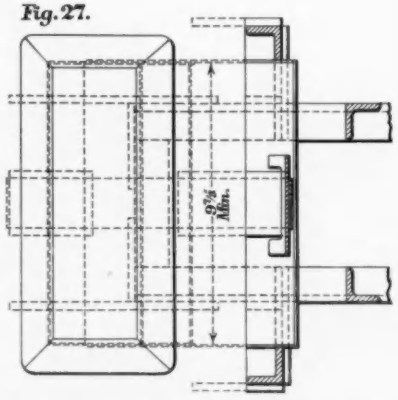


Fig. 28.

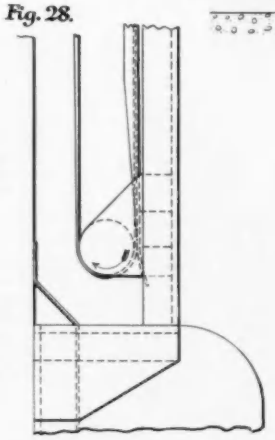
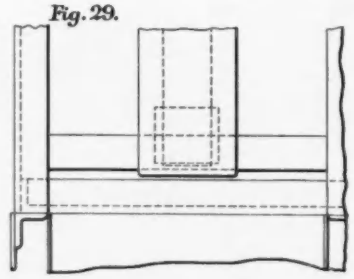


Fig. 29.



UNIV. OF MICH.

ENGINEERING.

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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of Publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

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ENGINEERING

FRIDAY, APRIL 26, 1940.

VOL. 149. No. 3876.

WOMEN IN MUNITION FACTORIES.

IT has recently been stated that there are now 300,000 women workers in the munition factories of France and that a schedule of machine operations is being compiled for which the employment of female labour will be obligatory. It is also stated that certain types of industry in France are to be restricted to women. It may be assumed that these latter industries will be those which, as in this country, are mainly carried on by labour of that class in normal times. None the less, there is no doubt that dilution by female labour has been carried to greater lengths in France than here. Although, presumably, the normal proportion of women in major industries in this country is known, it is quite possible that in the special circumstances now ruling accurate figures are not available. The whole position should, however, be made clear by the census of labour in war industries which is being undertaken under the Factory Undertakings (Record and Information) (No. 1) Order, 1940. The first returns under this Order were to be made by April 10. Others will follow at quarterly intervals.

It may be taken as a major axiom of our present situation that, as the war progresses and as new factories and factory extensions come into operation, great additions will be necessary to the number of operatives employed. Mr. Burgin, the Minister of Supply, is continually calling for greater output. Speaking at Wolverhampton on April 6, he appealed to machine-tool makers to see that all their manufacturing machines were in operation for twenty-four hours a day. This appeal calls for no criticism, as clearly only by willing response can new and extended factories arrive at the production stage in the minimum time. It is not, however, the only available method by which production may be increased; another and additional procedure is to run the machines in existing factories also for twenty-four hours a day. There are works in this country running day and night for seven days a week, but this condition by no means applies to all. If it can be extended to the great majority, valuable additions to output will be secured. It is clear, however, that this procedure will only be possible with a much enlarged labour force in the munitions industries and this will involve greatly increased employment of women; there is no other source of supply.

In some quarters it is the practice to argue that no increase of women in munition factories should be permitted until the whole of the unemployed have been absorbed. The first point in any reply to this contention is that the latest unemployment figures, those for March 11, show that one-third of the totally unemployed are, in fact, women and girls, so that even on this argument there would apparently be no objection to placing some 300,000 women in the munition factories. Unquestionably, a considerable proportion of them will ultimately go there, but many are unsuitable. This is also the reason why the 650,000 unemployed men and boys cannot be transferred to munition works in a body. An unemployed man, merely because he is an unemployed man, is not necessarily likely to be of value in a machine shop. It is certainly wrong to assume that he is likely to be of greater value than a girl. A builder's labourer, over fifty years of age will probably prove a considerably less apt worker at a capstan lathe, or on a repetition grinding job, than a woman of half his age. As the number of unemployed fell by 382,887 between February 12 and March 11, the unemployment problem may be said to be solving itself. The workpeople are being drafted to occupations of all types and, in so far as they have a trade, it is desirable that they should find employment in which their skill can be utilised, provided their particular trade is of value in war time. An example is furnished by unemployed coal-mine workers, for whom the activities of the newly-formed Coal Production Committee may be expected to find work.

The fact that the unemployment figure, which includes a large number of elderly people and many unemployable, is still high is no reason for any hesitation in proceeding to place large numbers of women in our munition factories. The new French regulations restricting certain machine operations to women, to which we refer above, may sound drastic, but similar regulations were issued and complied with in this country in the war of 1914-18. As pointed out in the January-February issue of the *Machine-Tool Review*, the house journal of Messrs. Alfred Herbert, Limited, the Ministry of Munitions in 1917 instructed that by March 31 of that year 80 per cent. of the workers engaged on new and continuation contracts for all sorts of shells up to 4·5 in. must be women. Actually at that time the employment of women was by no means restricted to shells of this or similar calibre. An example may be quoted of a shell factory in the North, which turned out two million shells of the 9·2-in. and 6-in. high-explosive types, and 60-pounder shrapnel, in which, including the tool room, 55 per cent. of the production employees were women. In this case, for the heavier shells, assistance in lifting operations was given by men, but all machining was carried out by women.

The trade unions have, in general, shown themselves very ready to co-operate in increasing output, but a good deal of red tape still entangles the negotiations which are being carried on. What is required at the moment is that all restrictions on the employment of women and other unskilled labour, from the points of view both of the hours that may be worked and the jobs that may be done, should be swept away. The particular interests of the unions, which it is their duty to guard, could be secured by a general agreement to revert to the normal position at the end of the war. Even with the most generous concessions, the unions need not have the slightest fear that the women will become skilled turners and fitters; it might be well if they could. In the shell factory referred to above, shaping machines in the tool room were operated, from the first, by women, some of whom ultimately became valuable semi-skilled shaping-machine hands. These were the exceptions, how-

ever; the majority of the women were employed on a single repetition operation throughout, and those whose ability enabled them to be put on to a new operation, and to learn to do it any more quickly than a raw hand, were very few. On the operations with which they were familiar, however, the women were very successful and training required was short. An analysis of the labour force showed that nearly 50 per cent. of the women employed were Lancashire mill hands, who were consequently used to running machinery, although of an entirely different type. This probably partly explains the facility with which the majority learned their new jobs.

As suggested above, in addition to the removal of restrictions on the type of work done, it is also necessary that all regulations concerning the employment of women on night work should be abolished. In the case of the factory above referred to as an example of what was done in the past, all operations were carried on by night as well as day, the night shift working from 7 p.m. to 7 a.m. No difference was made in the hours of men and women workers. Health conditions were satisfactory throughout. Taking the year 1916 as an example, the percentage of lost to possible time for men was 7·33, the corresponding figure for women being 8·02. As a larger percentage of lost time among women than among men, especially on comparatively heavy work of the type concerned, would naturally be expected, these figures show that the conditions had no specially injurious effect on the health of women workers. At the present time, when black-out precautions have resulted in the conditions in many shops being little different by day and night, there is even less reason than there might have been in the past for suggesting that night-shifts should be worked exclusively by men.

In the time to which our reminiscences refer, it was usual to provide women charge hands to supervise the behaviour of the women workers. They were available for consultation in difficulties or disputes, but technical matters had to be referred to male charge hands or tool setters. All these officials were under the jurisdiction of a foreman. It is clear that, whatever type of shop government is preferred, it is necessary that a woman worker should have the right of appeal to a supervisor of her own sex, and if the female charge hands, or whatever they may be called, can have technical competence in addition to the judicial qualifications which are necessary, their value will be greatly increased. This lends interest and importance to the training scheme which is described by Miss Verena Holmes in the article appearing on page 407 of last week's issue. Being operated on an almost private basis, the scheme is not yet of great magnitude, but its operations might perhaps be extended to cover the requirements of industries other than engineering which may, sooner or later, find it necessary to employ women workers in increasing numbers. In the previous war, for instance, large numbers of women were engaged on skilled and semi-skilled operations in shipyards and, generally speaking, their work was satisfactory.

THE WORK OF THE CENTRAL ELECTRICITY BOARD.

Although the statistics of the country's electricity output formerly issued each month by the Electricity Commissioners have not been published since the outbreak of war, the speeches of the chairmen at the annual general meetings of a number of supply undertakings, operating both in London and the provinces, have to some extent indicated the effect of hostilities on this important national industry. As in the case of the railways, the first nine months of 1939 were a period of increasing prosperity, although, unlike the railways, the electricity supply industry has made continuous progress, at least since the temporary set-back caused by the General Strike fourteen years ago. With the outbreak of war, however, the cessation of street, display and shop-window lighting, as well as evacuation, official and unofficial, from the large towns, all had a retarding effect, which was assisted rather than counteracted by the change over from peace to war-time conditions in industry. All these harmful influences have been reflected in the balance sheets, and though the underlying causes are not quite the same as in those of the retail concerns, this is equally true of the Central Electricity Board, whose twelfth Annual Report,* for the year ended December 31, 1939, was published last week.

The effect of the war upon the Board's trading activities has been serious and although it is still too early to predict with accuracy the extent to which it will reduce the trading surpluses budgeted for, it is possible to forecast the general trend which is being taken by the wholesale branch of electricity supply. In the first place, for reasons which need not be stressed, a larger amount of relatively inefficient plant has had to be kept in operation than would normally have been the case, and this in itself will have an obvious reflection on the financial results. As already pointed out, the "black-out" and the curtailment of the load of non-essential industries has caused a substantial reduction in the aggregate maximum demand, and it is regarded as unlikely that any material increase in that aggregate will take place during the war. This reduction will be only partially compensated by the increase in output caused by munition and other factories working on a three-shift basis, though there will naturally be some improvement in the load factor. Unfortunately for the Board, the position is made worse by the virtual necessity under which it has been placed of planning ahead. Capital generating stations are not built in a day, but it is nevertheless essential that they should be ready when required to take their share of the load. Plant extension programmes due for completion during 1940 and 1941 have therefore been in hand for some time and their completion will result in an increasing margin of spare generating plant becoming available as the war proceeds. It is probable, too, that this margin will not be reduced to normal proportions for some time after the cessation of hostilities. In the maintenance of this margin at a low level, however, resides one of the Board's chief sources of revenue, and there is no reason for surprise, therefore, in the hint that, as this level will be increased above the minimum economic datum, it may be necessary to follow the example of certain retail undertakings and to increase the tariffs.

During the year, the capital fund of the Board remained at 52,500,000*l.*, of which 36,725,000*l.* was for general purposes and 16,775,000*l.* for frequency standardisation. For complicated reasons of accountancy, the revenue account can only be completed promptly by the inclusion of provisional figures. These show a balance of 3,134,128*l.*, which is an increase of 379,760*l.* over 1938. This is only about half the increase of 1938 over 1937, but the result was, of course, attained with eight months normal operation. A sum of 1,417,923*l.* was contributed to the redemption fund, and 2,433,716*l.* was carried forward to meet the interest and redemption fund charges. A further financial item is the amount borrowed under the Central Electricity Board (Civil Defence) Borrowing Regulations, 1939, to defray the industry's share of the capital cost of providing a pool of switchgear, transformers and other equipment for use in replacing plant put out of action as a result of air raids. Consent was given to borrow 1,000,000*l.* for this purpose, but actually no stock was issued, payment being made by means of Exchequer grants and temporary advances by the Bank of England.

So much for the financial effect of the war on the Board's fortunes; the problem may also be dealt with from a more technical aspect. The manufacture of the plant required for 1939, 1940 and 1941 was in a more or less advanced stage of completion during last summer, while the programme of extensions due for commissioning during 1942, to meet the estimated load under peace-time conditions in that year, had been settled. These estimates made it clear that at least one new selected station would be required in every grid area during 1942 or 1943, and that further new stations would be needed shortly afterwards. Plans had been prepared for the erection of fifteen new stations, five of which were to be in South-East England, and when war was declared some of the contracts had been placed. It then became necessary to review the position. At that time, of course, hostile action from the air was anticipated, and the idea was considered of retaining for use in this country generating plant and boilers which were being manufactured for Empire undertakings. For technical reasons, however, this was only partially practicable, while an examination of the position indicated, as we have already said, that the demand during the war was likely to be substantially below peace-time estimates. It was, therefore, decided not to proceed with the full programme for 1942, though, should matters take an unexpected course, work on this could be resumed without much delay.

War-time exigencies prevent the publication of many figures of progress. It may be said, however, that the number of selected stations in use during 1939 was 137, all except one of which were operating under the direction of the Board, while the total installed capacity was 8,658,000 kW. The grid comprised 4,430 route miles of transmission lines, 3,039 miles of which were operating at 132 kV, while there were 307 switching and transforming stations with an aggregate capacity of 10,971,000 kVA. During the year, 97·4 per cent. of the electricity supplied by the distributing undertakings in the country was produced at stations which were generating for the Board, and during the first eight months of the year one-half of this amount was generated in 14 of the largest stations. Work was continued on the best means of reducing the stresses due to lightning on inductive apparatus, and, a 33-kV laboratory model of a new type of arrester having been tested by the Research Association, its application to the grid is now being considered. The use of Petersen-coil equipment was also extended on the lower voltage sections. Important work was undertaken on the modernisation of the 132-kV circuit-breakers already installed, as a result of data relating to their performance which have been obtained from the various testing stations. The speed of clearing short circuits was improved, in particular, and tests were undertaken to determine the rate of rise of restriking voltage. Additional 132-kV high-speed low oil-content circuit breakers were put into service.

Field tests on primary overhead line and sub-station insulators disclosed that the number of faulty units was small, and that the anti-dirt insulators, which had been installed previously at certain substations, were entirely free from flash-over. The protective equipment had to operate on many more occasions than in previous years; nevertheless, the percentage of faults correctly cleared—91 per cent.—was the highest yet recorded. Further development took place in the design of oil-filled cables for 66-kV operation. The early cables designed for that pressure were of the single-core type, but three-core cables are now being used. This, with a reduction in the thickness of the dielectric, has enabled the weight of material required per kilowatt transmitted to be substantially reduced without sacrifice of security. The internal nitrogen-filled 132-kV cable first installed in 1937 has been extended and a new form of 66-kV external nitrogen-pressure cable has been ordered. The work of the Research Association was also seen in the new power transformers ordered during the year. These incorporated improvements designed to increase the resistance of the windings to the electrical stresses resulting from lightning and from the mechanical stresses imposed on them by external short-circuits.

An extensive series of tests was made to determine the intensity of noise emitted by transformers and it is now possible to specify the noise limits of this class of apparatus in advance. As in recent years, several undertakings found it desirable to make arrangements with the Board for an increase in the voltage at which their systems were connected to the grid. On the engineering side it may, therefore, be conceded that satisfactory progress is taking place, and that every care is being exercised to ensure the maintenance of a high level of efficiency. Some comfort may also be derived from the fact that these developments may be accelerated by the stringency of the times and further economies thereby realised.

* *Central Electricity Board. Twelfth Annual Report.* London: Whitehead Morris, Limited. [Price 1*s.* net.]

NOTES.

THE INCREASED RAILWAY CHARGES.

IT is estimated by the Railway Executive Committee that it will cost 26,750,000*l.* more to operate the railways, from the beginning of the control in September last, until March 31, 1941, and the Minister of Transport stated in the House of Commons last week that he was satisfied that an increase of 22,250,000*l.* had been proved. He has made an Order, therefore, authorising an addition of 10 per cent. to all railway charges, including fares, on the railways of the London Passenger Transport Board, from May 1; though the consideration of objections to this course by representative bodies of railway users is not excluded. The figure of 22,250,000*l.* is made up of 9,750,000*l.* for increased labour costs, 2,500,000*l.* for allowances to men serving in H.M. Forces, and 10,000,000*l.* for increased cost of material, including fuel. The difference of 4,500,000*l.*, between 26,750,000*l.* and 22,250,000*l.*, is due to expenditure on the "black out" and other precautionary measures, and is to be examined in the light of further experience. This increase in charges was not unexpected, though the Minister and through him the Government have invited a measure of justifiable criticism by the method in which they have implemented it. There seems no real reason, in fact, why the question should not have been submitted to the Railway Rates Tribunal in the ordinary way. The argument that this could not be done because "time was the essence of the contract" can hardly be maintained, and still less can the statement that the virtual suspension of the Tribunal has been for the protection of the railway users. The fact is that the Ministry have laid themselves open to the charges of hearing only one side of the case, and of being judge and jury in their own cause; for it must be remembered that the Government is now a guarantor of the railways' profits, and it is therefore to their advantage that, as far as possible, these should be maintained at or near the agreed datum line. To have made up this amount from the Exchequer funds would have spread the burden over the whole nation, and if the railways are to be considered as a national charge this would have been an equitable course. As it is, those who use the railways will suffer seriously, while others will escape more or less entirely. The increase in goods charges, too, cannot fail to bring about rises in the cost of living, which the Government has stated it is doing its best to prevent. The Consultative Committee, comprising the members of the Railway Rates Tribunal, has been asked to advise on means of obtaining a corresponding increase from the London Passenger Transport Board's road services.

THE INSTITUTION OF CIVIL ENGINEERS.

At a well-attended luncheon held on Friday, April 19, the Institution of Civil Engineers maintained, though in a manner in consonance with present conditions, its traditional hospitality to a large number of distinguished guests. The President of the Institution, Sir Clement D. M. Hindley, K.C.I.E., M.A., occupied the chair. After the toasts of "H.M. the King" and "The President of the French Republic" had been honoured, the Rt. Hon. Sir John Anderson, Minister for Home Security, proposed that of "The Institution of Civil Engineers." After paying a tribute to the general work of the engineer, Sir John dealt with the question of civil defence. In the matter of protection of the population, the engineers concerned had had to depart from customary practice, in that it had been necessary to proceed with designs and even to execute work before all the statistics and data desirable were available; yet severe tests had shown their work to be sound in both conception and execution. There might be still greater tests, but there was a reliable factor of safety in the moral fibre of our people. Constructional difficulties, however, were not yet all over; material was now being restricted by the pre-emption of timber and steel, but the engineer was proving successful with structures of unreinforced concrete and brick. Sir Clement Hindley, in reply, and in proposing the toast of "The Guests," paid a tribute to Sir John's own share in the development of civil defence. If the rest of the country was as well prepared as London, it was ready for any likely eventuality. The Institution was faced with difficulties at the outbreak of war, but the Council had decided that no lowering of standards should occur, and that its young men should not be obstructed in their studies. He thought the Government had considerately met the situation in connection with the calling up of students, alternatively arranging for suitable duties if called up. The work to be done, after the coming of peace, had been alluded to, and the Institution was fully alive to its responsibilities in the matter of the enormous amount of it which would be involved in reconstruction. The toast was responded to by the Right Hon. Sir John C. W. Reith, P.C., G.C.V.O., the Minister of Information, who, after acknowledging the hospitality of the Institution on behalf of his fellow guests, referred to the fact that he was also a member and expressed the wish that the place he occupied that day had been due to some outstanding work in civil engineering rather than to the more fortuitous circumstance of his present position.

DISTRIBUTION OF INDUSTRIAL POPULATION.

The Report of the Royal Commission on the Distribution of the Industrial Population, upon which we commented on page 174 of our issue of February 16, was debated in the House of Commons on Wednesday, April 17. It is right that we should consider in broad terms what will be the position after the war, and Mr. R. Lawson was able to make out a good case for some controlling authority, such as that suggested by the Commission. For instance, he pointed out, the Ministry of Supply had favoured the establishment of large factories—some in agricultural districts—which, after the war, would be surplus, instead of erecting smaller ones in areas which had suffered in the past. Mr. K. Griffiths said that in areas like Tees-side there was every prospect of the nightmare of war being followed by the nightmare of slump, while Mr. A. Price observed that it was no good trying to attract new industries to areas where they were desirable unless difficulties were placed in the way of industries going to areas where they were not wanted. Mr. Herbert Morrison contended that something should be done to limit the further spread of the Metropolis, while Mr. Edwards suggested rather surprisingly that steps should be taken to increase the production of aluminium and electrical energy in the country and complained that no authority existed for the encouragement of such enterprise. In reply, the Minister of Health said that on many points the Government were transcending the recommendations of the Commission. The population of evacuation areas had diminished by 2,250,000 persons and of these, 1,500,000 had been lost by London. The great aggregation of population in London had, therefore, been checked by the course of events. It would be foolish not to examine the results of this great experiment before rashly pledging ourselves to follow any particular course. In regard to the siting of factories, a "liaison machine" had been set up to cover the three Service Departments, the Ministries of Agriculture, Labour, Transport, Health and the Scottish Office and Office of Works. All these had to be consulted before a factory was sited, and the investigation was far from casual. Offices, hostels and hospitals were being built so that they could be used after the war. Though it was not the Government's view that the proposals in the Report should be postponed until after the cessation of hostilities, it would clearly be premature, at the present time, to weigh the ultimate merits of the recommendations and reach conclusions.

THE INSTITUTION OF ENGINEERS-IN-CHARGE.

The fortieth annual dinner of the Institution of Engineers-in-Charge was held at the Holborn Restaurant, London, on Friday, April 19, the President, Sir Alexander Gibb, G.B.E., F.R.S., being in the chair. It was stated that, in spite of the war, the attendance was a record. After the King and our Allies had been duly honoured, the toast of "The Institution" was proposed by Sir Clement Hindley, K.C.I.E. In peace time, he said, the engineer in one way or another was in contact with every aspect of human life, while in war it was becoming ever clearer how much depended upon his skill and efficiency. This should serve as an inspiration. While in war time many things had to be improvised, the need for efficiency was great, if we were not to suffer defeat and slavery. One thing to which sufficient attention had not been given was fuel economy. This was of vital importance at the present time, though it was still not recognised in many industries, where the fuel formed only a small part of the total costs. In reply, the President said that the Institution acted as a link between the academic and practical engineer, and he was certain its successful future was assured. They had recently been discussing whether the Institution fulfilled its purpose, and it seemed to him they had three important tasks to perform: To meet and discuss wider issues than their own immediate tasks, to make it clear that the cheapest article and the worst workmanship were not the most desirable of aims, and to enable engineers to inter-communicate and so keep abreast of the times. In reply to the toast of the "United Services," proposed by Sir Leopold Savile, Engineer-Vice-Admiral Sir George Preece said that if he was not an engineer-in-charge himself, he was at least in charge of a great many engineers-in-charge. To them we owed a great debt of gratitude. They had enabled a certain ship to be kept at sea for 113 days out of 119, and one of those which took part in the Graf Spee battle was already a year overdue for refit. Though it might be argued that any opposition had a perfect right to upset an existing regime, it had first to prove that the world would be a better place to live in as the result of the change. It was because we did not believe it would that we were fighting now. In particular, the Services were determined that unprovoked aggression against smaller nations should depart from the earth. The toast of "Our Guests and Friends," was proposed by Mr. C. D. Lightfoot and responded to by Mr. Johnstone Wright, while that of "Our President" was proposed by Mr. A. Sinclair.

THE JUNIOR INSTITUTION OF ENGINEERS.

To judge by the attendance, the decision of the Council of the Junior Institution of Engineers, to hold a luncheon in place of the customary annual dinner, was fully justified. The function took place in London on Saturday, April 20, the chair being taken by the President, Sir Charles Bressey, C.B., C.B.E., who had accepted a second year of office in view of the difficulty foreseen by the President-elect, Lord Falmouth, in taking over the responsibilities of that position in war time. The toast of "The Institution" was proposed by Sir Clement Hindley, president of the Institution of Civil Engineers, who recalled that, in so doing, he also was retaining his office of the preceding year. He congratulated the institution on its flourishing condition in a period of national stress. Dr. Herbert Chatley, M.Inst.C.E., chairman of the Institution, who responded, said the place of the engineer in modern life was much more important than the public realised. Engineering progressed at a compound-interest rate, and in some respects was now proceeding inconveniently fast. Sir Leonard Browett, K.C.B., Permanent Secretary to the Ministry of Transport, replied to the toast of "Engineers and National Service," proposed by the President, and observed that his Department was now responsible for spending between 20,000,000*l.* and 30,000,000*l.* annually on engineering work. He had been impressed, in the negotiations which this expenditure involved, by the helpful attitude of the engineers with whom he was brought into contact. Much of their work was interrupted by the war, but the staff of the Department was not less active on that account, and had raised a large number of technical units for service with the Forces. To the toast of "Our Guests," proposed by Mr. N. L. Ablett (vice-chairman), there were two responses. Mr. Asa Binns, president of the Institution of Mechanical Engineers, commented on the peculiar camaraderie to be found among "the Juniors"—an atmosphere which might well be envied by many members of other institutions.

Mr. Johnstone Wright, president of the Institution of Electrical Engineers, deplored the manner in which science was being debased for warlike purposes and observed that the eventual reconstruction would make heavy demands upon engineers. A vote of thanks to Sir Charles Bressey for his services in the chair, proposed by Mr. J. W. Stenson (vice-chairman) concluded the proceedings.

Additional Labour for Munition Work.

Included in this week's "Labour Notes," on page 446, is a brief report of the discussion which took place in the House of Commons on April 16, on the Vote for the Ministry of Labour, regarding the provision of additional labour for munitions. The Minister of Labour (Mr. Ernest Brown, M.P.) then stated that, in his calculations of man-power, he had included women, and the employers and trade unions had expressed their readiness to help in obtaining the necessary personnel. Since that paragraph was written, it has been announced that negotiations between the engineering employers and the unions concerned are to take place next week, on the subject of the conditions under which women are to be employed on such work during the war. As is pointed out by the Labour Correspondent of *The Times*, the unions principally affected are those of the semi-skilled and unskilled branches, as the dilution brought about by bringing in women to do work customarily done by men does not directly affect the Amalgamated Engineering Union, which is concerned with skilled labour. An agreement is already in force between the A.E.U. and the Engineering Employers' Federation for the relaxation of customs and practices, and more recently a new agreement has been made between the Admiralty and the skilled trades regarding the employment of additional labour in the Royal Dockyards.

THE INSTITUTION OF MECHANICAL ENGINEERS.

A general meeting of the Institution of Mechanical Engineers was held on Friday, April 19, at Storey's-gate, St. James's Park, London, S.W.1. The chair was occupied by the President, Mr. Asa Binns, during the transaction of the routine business, and later by Mr. Sterry B. Freeman, vice-president.

Singing Propellers.

The main business of the meeting was the reading and discussion of a paper entitled "The Problems of the Singing Propeller." It was presented by Professor W. Kerr, Ph.D., Dr. J. F. Shannon and Dr. R. N. Arnold, and described the results of a prolonged investigation carried out at the Royal Technical College, Glasgow. To ensure protection against singing, they stated, it appeared to be of paramount importance to eliminate all types of exciting forces; to produce a blade with low responsiveness to arbitrary forces occurring at the tip and leading edge; and to ensure a hydrodynamic flow to the propeller, with the minimum of resistance. It was concluded that a simple but effective method of safeguarding a propeller against singing was to sharpen suitably the leading edge, the tip, and the trailing edge. The first controlled cavitation; the second, vortex action; and the three together introduced intense hydrodynamic damping. Exciting forces and elastic response were thus reduced to a minimum, and, if the wake was not abnormal, success seemed almost certain.

The discussion was opened from the chair by Mr. Freeman, who observed that the elusiveness of the problem was striking; it was not practicable to see what happened to a propeller in service or to measure its vibration directly. Some time ago a well-known shipbuilder had produced two similar ships. Both had similar propellers, but those of one vessel were so noisy that it was impossible to hear the sound of the telegraph in the engine-room, in consequence of which Lloyd's Register could not approve the vessel. The offending blades were scrapped, and other propellers fitted. The ensuing litigation was carried as far as the House of Lords.

Major P. L. Jones, M.C., remarked that, though he had attended over 300 trials of ships of all types, he had not heard of a singing propeller until about five years ago. More recently, however, the matter had been more fully discussed, and any propeller that was not absolutely silent was accused of singing. In his experience, more cases of singing had been observed with aerofoil-section blades than with those of segmental section, which fact seemed to support the authors' conclusions as to the importance of sharp edges, since the average aerofoil section was much blunter than the segmental one. The damping experiments on blades in water described in the paper were interesting, and it was both fortunate and unexpected that sharpening the edges of the blades so enormously increased the damping effect. The author's statement that small differences in end fixing greatly affected the response of the blades to the more complex forms of vibration helped to explain the different results obtained from the commercially-identical propellers of twin screw ships. As far as could be seen, these propellers appeared identical, but one might sing while the other did not; perhaps slight differences in the fixing of individual blades accounted for the variation.

One of the worst cases of singing within his experience was with a twin-screw passenger ship having solid bronze propellers of aerofoil section. On the trial trip, the propellers were visible over the side of the vessel, though the tips were 5 ft. under water. A perfect vortex-swirl was seen to be produced, and to be thrown from the blade tips throughout the engine speed range, namely, from 60 r.p.m. to 120 r.p.m. The singing started at about 60 r.p.m. and increased in intensity to a maximum lying between 95 r.p.m. and 100 r.p.m. From this latter speed it decreased, though it was still present at 120 r.p.m. He had observed similar conditions on other ships, but, if cavitation was such a decisive factor as was suggested in the paper, the noise might be expected to increase as the propeller revolutions and load on it increased. In no case of singing within his experience was there any indication of poor propulsive efficiency, so that if cavitation were present it must have been extremely slight.

Dr. S. F. Dorey said that although the phenomenon might be a serious one for a shipbuilder, it was not very common. He had looked into the question of singing propellers some three or four years ago and had only come across between fifty and sixty cases out of 10,000 vessels. The author's arguments seemed to lead to the inference that the noise from a singing propeller emanated from free vibrations of the blade due to impact loading, the impacts being the same as those causing cavitation. There was evidence both for and against this. In some cases, singing propellers had shown cavitation pitting but, again, large numbers of propellers showing severe cavitation had run silently. The critical nature of the singing suggested other disturbing forces than those of impact and in some cases the note suggested a high-frequency exciting force. The work of Troost indicated possible pressure fluctuations on the suction side of an aerofoil section which might produce a high-frequency exciting force, and showed that with segmental sections no such unstable conditions were produced. It also indicated that very small imperfections in the form of the leading edge of the aerofoil sections gave rise to the pressure fluctuations in question. He suggested that the authors could profitably carry out experiments with some slight irregularities at the leading edge on the suction side and with small angles of incidence to determine the influence, if any, of such irregularities. Experiment had shown segmental sections to produce more even pressure distribution at the suction side of the blade.

An important point had emerged that sharpening the leading edge increased the critical speed at which cavitation occurred, and that in actual propellers such sharpening had completely eliminated singing. The authors concluded that cavitation caused singing; but some propellers ceased to sing as the rotational speed increased, a fact that seemed to indicate that singing was due to something more critical than cavitation. There was a great difference between the strips used by the authors in the hydrodynamic damping experiments and actual propeller blades and he doubted whether these experiments could be considered conclusive for the claims made. Indications from practice were that singing resulted from lateral vibration of the blade, in which case maximum hydrodynamic damping would occur at points of maximum amplitude—presumably the trailing edge of the blade. Here vortices of high frequency were formed and the accompanying pressure waves might have a pronounced influence on the hydrodynamic damping. Hysteresis damping would have little effect unless the stresses were high. Blades of cast iron, which had high damping qualities, had given satisfactory service and, in general, had been found free from singing. In one case, where a cast-iron propeller was so noisy that the seamen were unable to sleep, it was found, on its removal, that the metal was of a very high quality and its damping capacity was, therefore, not so good.

Mr. Allan W. Davis could not endorse the finding that a sharp-edged blade would prevent singing. His own firm had always produced propellers with edges as sharp as practical considerations permitted, yet some of them had sung to a degree that was, until recently, unpredictable. Again, consideration of representative blunt-edge propellers showed that the occurrence of singing was by no means a foregone conclusion. Extensive analysis, coupled with practical success, had convinced him that the real criterion governing singing was dynamic, being, in fact, the relative degree of elastic response of the blade and having no connection with the contour of the blade edge. Mr. Davis then cited a case in which two successive modifications were made to a singing propeller. The first of these, viz., the sharpening of the blade edges and the reduction of the overall diameter, effected no improvement. In the second, which effected a complete cure, local thinning of the back of the blade had been carried out, this operation having the effect of destroying the natural vibrational frequency of adjacent cross-sections of the blade. He thought the analysis of the various possible modes of vibration was unduly complicated by the inclusion of modes not occurring in a fundamental form. Their results were based on bowing experiments with a small model, the comparatively large disturbing force created being out of all proportion to the actual conditions applying to a working propeller. He had experimented with flat-faced blades 3 ft. long, weighing 2 cwt. each, and cast in bell-metal to intensify the resonant quality, and had found it impossible to excite more than about half of the fundamental forms illustrated in the paper.

Though the authors had not ascertained the controlling feature of singing, they had made important progress in ascertaining that sharp edges promoted increased hydrodynamic damping, and had reduced, but not eliminated, hydrodynamic disturbance. But if sharpening was useful in this way, it was not practicable to employ it for all purposes. The primary function of a propeller was to transmit power with maximum efficiency, and the most attractive remedy for possible singing was that causing least modification to the most efficient design. Some designers maintained that a bull-nosed aerofoil section was desirable and would be unwilling to sacrifice this feature in the hope of eliminating singing. Moreover, a sharp propeller tip was more vulnerable to damage by floating objects, ropes or sand. The impression conveyed in the paper as to the wake being a stream flowing in the direction of the vessel's movement was not correct, since the lines of the ship caused a transverse deflection of this stream, the effect of the bossing in multiple-screw ships being very marked in this respect, where the water passed the after end of the fin joining the hull. If the bossing were correctly designed for one condition of loading, a change of trim or draught would set up these cross-currents, while waves and pitching would have the same effect, causing wide variations in the angle of incidence. It was to be hoped that the authors could provide an appendix to the paper which would help a designer as to the degree of sharpness of blade edge recommended and the extent of the periphery that should be thus treated.

Professor B. P. Haigh observed that the paper offered little definite advice as to what to avoid in order to make propellers free from the liability to sing. He had already suggested, in connection with a

paper read elsewhere, that singing occurred when three characteristics were present simultaneously. The problem was not one of simple resonant vibration, otherwise every propeller would sing at some speed or other. The three characteristics he referred to were the frequency of eddying, the lateral mode of vibration, and the torsional mode of vibration, the two latter combined being that arising from the action obtained when sculling a boat with a single oar. He thought the paper had unduly neglected the eddy frequency, the study of which was at least 50 year old. Professor Haigh then discussed the proportions of the cross-section of a propeller blade, so that the equation for determining the frequency of the water eddies could be more accurately stated. Although this frequency was very important, two other things had to resonate with it to produce singing, viz., a frequency of bending vibration and a frequency of torsional vibration. He had, some time ago, worked out a purely hypothetical case, taking a uniform strip of elliptical section. When the conditions under which the bending and torsional vibrations would be identical were arrived at, certain proportions between the length and breadth of his example appeared, which proportions were very nearly those of an ordinary mercantile propeller and far removed from those much broader and smaller-radius propellers used for more powerful ships. Any change which brought about the separation of these two frequencies would seem desirable.

Mr. L. C. Burrill prefaced his comments by the playing, on a gramophone, of an interesting record of the noise of a singing propeller as heard in different parts of a ship. The propeller concerned, he explained, had been modified without sharpening the leading edges and was afterwards found to be quite silent in operation. In the absence of facilities for investigation with propellers of reasonable dimensions, the authors had attempted, by means of model experiments, to obtain indirect information which might throw some light on the various problems. The final conclusions arrived at, however, did not accord with the experience of others and himself. In discussing cavitation, the paper mentioned the effect of high suctions and the influence of powerful tip vortices. The nature of the former type of cavitation was well known and it was controllable by suitable design, but the extent and character of the latter type was still obscure and the matter was worthy of further experimental investigation. He thought the account of the wind-tunnel experiments indicated the very small effect of the sharpening of the leading edge. The plotted results of the influence of speed and wake variation on propeller cavitation seemed inconsistent with the observed facts for actual propellers, since they suggested that, while one section would sing at above, say, 45 r.p.m., another section, supposed to be silent, would sing above about 80 r.p.m. His own experience was that singing usually occurred at several, more or less short, ranges of revolutions per minute and was more usually associated with a low, rather than a high, number of revolutions. In one instance, a propeller, otherwise silent throughout the whole working range, was observed to sing while the engines were stopped, the vessel being still under way.

He considered the results of the water tests with model blades to be of little practical value on account of the large thickness ratio and the abnormal shapes of the sections tested. The results of experiments with various tip contours opened up a new line of enquiry but there, again, the thickness ratio seemed to be too high and the shapes abnormal. As to the conclusions given at the end of the paper, the statement that the sharpness of the leading edge was the controlling factor in relation to cavitation would not, in his opinion, be generally accepted as correct by propeller designers. Mr. Burrill then dealt with a specific case of propeller modification to eliminate singing mentioned in the paper, and in which modification he had been concerned, and gave some particulars of other cases in which his firm was involved. In this connection he stated that, in the firm's experience, covering propellers of all sizes and supplied during the last four or five years, it had not been found necessary to design them with sharp edges to avoid singing. During that period, only one propeller had been found to sing and that at revolutions corresponding to about half the normal full power, but it should be noted that, in this case, the firm's normal design procedure was not completely followed, for reasons not connected with singing characteristics.

Dr. Arnold briefly acknowledged the vote of thanks accorded, and stated that the authors would reply to the discussion in the *Proceedings*.

THE LATE MR. P. F. ROWELL.

We regret to record the death of Mr. P. F. Rowell, which occurred at Weymouth on Sunday, April 14, at the age of sixty-five. Mr. Rowell was well-known to electrical engineers and others as Secretary of the Institution of Electrical Engineers, a position from which he had only retired at the beginning of the present session.

Percy Fitzpatrick Rowell was born in London on September 10, 1874, and was educated at the Royal College of Mauritius, where he was awarded a gold medal for mathematics and a leaving scholarship in 1893. After studying at King's College, London, and occupying several business positions as an accountant, he joined the staff of the Institution of Electrical Engineers in 1901, under the then secretary, Mr. W. G. McMillan. On the death of Mr. McMillan in 1904, Rowell was appointed assistant secretary under the new secretary, Mr. G. C. Lloyd, and when the latter was transferred to the Iron and Steel Institute in 1909, Mr. Rowell was promoted to take his place. This position, as we have already said, he held until his retirement in the autumn of last year.

During his occupation of the increasingly important office of Secretary, the membership of the Institution increased from 6,117 to 18,252, and the scope of its activities correspondingly widened. Owing to the formation of specialist sections, such as the Wireless and Transmission Sections in London, and the development of the provincial centres, more duties and responsibilities were, as time went on, thrown upon the secretariat. The same result followed as a consequence of the work of such committees as those dealing with the rules for electrical installations in buildings, and standardisation, and the general advance in the use of electricity for all purposes. Closer contact was also established with members overseas and with sister institutions in other countries. As regards the latter, Mr. Rowell's expert knowledge of the French language was a great asset and his work in this respect was fittingly recognised a short time ago by his appointment as Officier de la Légion d'Honneur and as honorary member of the Société Française des Electriciens. He organised several summer meetings of the Institution abroad and was an advocate of the extension of this form of the Institution's activities.

Mr. Rowell was elected an Associate of the Institution of Electrical Engineers in 1913 and transferred to the class of Companions under the new constitution in 1929.

Control of Timber.—The Ministry of Supply has made a new Order, entitled the Control of Timber (No. 10) Order, 1940, which came into force on April 4. The new Order brings veneer within the "acquisition" and "consumers" licensing system, except in the case of the classes of consumers already exempted from licensing under the No. 5 and No. 7 Orders. The Order also contains provisions applicable to timber generally; it provides additional powers for obtaining information and enables the Timber Controller to sell "National" stocks at prices exceeding the maximum prices specified in previous Orders. Copies of the new Order are obtainable from H.M. Stationery Office, York House, Kingsway, London, W.C.2, price 1½d., post free.

Withdrawal of Pioneer Locomotives.—The "Precursor" tank engines, 50 of which were built at the Crewe works of the then London and North Western Railway from 1906 onwards, have recently become extinct. They were of the 4-4-2 class, and were tank versions of the well-known Precursor express engine. On the formation of the London Midland and Scottish Railway, they were known as Power Class 3, and prior to the introduction of the now standard 2-6-4 tank engines on that system, undertook a considerable share of suburban duties in the London area. The London Midland and Scottish engine No. 17,925 has also been withdrawn. This was the last of 15 engines of the 4-6-0 type, which were introduced on the Highland Railway for freight and passenger duty in 1894. They were named the "Jones Goods," after their designer, Mr. David Jones, and at that time represented the largest type in Great Britain; their weight, we understand, was 94 tons.

LETTER TO THE EDITOR.

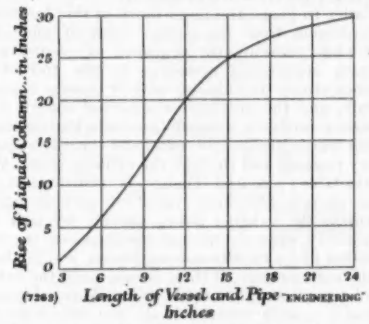
THE KADENACY SYSTEM OF SCAVENGING.

To the Editor of Engineering.

Sir,—I have been very interested to see from Dr. G. F. Mucklow's letter, published in Engineering on March 15, page 286, that his latest experiments on sudden discharge are—qualitatively—in agreement with mine.* Will you allow me once more to make some comments on the quantitative interpretation of Dr. Mucklow's measurements?

When considering the depression created by the sudden discharge, the picture is not complete unless the time during which this depression exists is taken into account. Whether the discharge process is visualised as consisting of distinct waves travelling through the discharge and being reflected at the end with a reversal of sign or as a surging movement of the whole mass of gas, the duration of the depression must always be related to the length of the system; that is to say, the combined length of the vessel and the discharge pipe, if any.

The whole process is so rapid that no ordinary form of direct measurement can hope to trace its course adequately, and indirect methods of observation have to be resorted to. Dr. Mucklow's suction gauge must be regarded as such a method and his results must be interpreted accordingly. It consists essentially of a length of tube filled, at the start of the experiment,



with air at atmospheric pressure, which dips at one end into water and is connected at the other end through a non-return valve to the vessel. The first point, which is easily verified, is that the water in the bottom end of the suction tube, owing to its inertia, does not move appreciably during the actual period of depression in the vessel, but merely replaces in good time the volume of air previously extracted from the tube. Thus the interpretation of this indirect method of measurement is reduced to an analysis of the flow of air from the suction tube through the non-return valve into the vessel when the depression in the latter varies in duration. However fine and light a non-return valve may be, it always has a finite mass and stiffness, its motion is opposed by damping forces and it offers some resistance to flow. The damping is probably largest with the valve on its seat, since air has to penetrate between the valve and the area it covers around the hole before it is lifted off freely. A non-return flap valve thus requires a minimum time during which pressure is applied before any appreciable opening occurs, and more or less well-defined resonance phenomena are to be expected.

The problem is complicated by the suction pipe, 3 ft. or more in length, in which oscillations in various modes may also be set up, in or out of resonance with the valve and the discharge system. The tube, being narrow, has a fair damping of its own, in addition to that of the valve. But as all the damping forces are relatively large, we may be justified in regarding the effects of the interplay of resonances as a secondary "disturbance" superposed on a general trend. We may arrive at this general trend or curve relating the volume of air displaced from the suction tube, or rise of water level, to the duration of the depression or combined length of the discharge system by the following considerations: Assume that the magnitude of the depression is uninfluenced by its duration. With long discharge pipes and consequent slow pressure changes, the characteristics of the non-return valve will become unimportant since the valve will be open long enough to permit pressure equilibrium in the suction tube and vessel to establish itself. Hence, from a certain point the rise of level will be independent of the length of discharge pipe. On the other hand, with a decreasing duration of the depression an increasing proportion of the available time is required to open the valve, the depression, in the form of a rarefaction wave, penetrates less far into the suction tube before the valve is closed

* See Engineering, page 122, *ante*.

again and the back flow while the valve shuts down increases because of a more rapid rate of pressure rise after the depression. In fact, as the discharge system is shortened the rise of level in the suction tube should fall off and reach zero when the vessel is so short and the discharge so rapid that the returning pressure pushes the non-return valve back on its seat before any air has had a chance to escape from the suction tube.

Dr. Mucklow's curve, part of which is reproduced on page 443, on an enlarged scale, shows such a general trend, and may be taken to support again the assumption, with which Professor Davies started this controversy, that only the duration, but not the magnitude, of the depression created by the sudden discharge from a vessel, is influenced by the existence and length of a discharge pipe. Dr. Mucklow in his letter and in his original article queried the possibility of creating an "appreciable vacuum" by a sudden discharge without some form of exhaust pipe. An "appreciable vacuum" being, by his definition, "a depression of sufficient magnitude and duration as to be effective for scavenging purposes in an engine cylinder." From this definition it appears that our disagreement really only turns round the importance attributed to the duration of the depression from the point of view of engine scavenging. Before discussing the point any further, it may be well to remember that it is inadmissible to apply quantitative conclusions from experiments carried out with air at room temperature to conditions in an engine exhaust where very much larger energies are available.

In order to gauge the importance of the duration of the depression from the engine point of view, it is worth while recalling the sequence of events in the Kadenacy scavenging system. At the end of the expansion stroke the exhaust valve or passage is opened suddenly, and the pressure or potential energy of the combustion products is transformed into kinetic energy. In other words, the gases expand and thereby acquire a velocity towards and through the exhaust port. When the available potential energy is transformed into kinetic energy, the inlet valve or port is opened, whereupon the exhaust gases, moving by now at a high velocity, draw air through the inlet into the cylinder, rather like a rapidly moving piston, and farther on into the exhaust pipe, if there *is* one, until the exhaust and inlet ports are closed. If this cycle is achieved no vacuum is actually created at all, and only if the inlet valve were not opened would the case be similar to that of the discharge vessel where the kinetic energy of the escaping gases is again transformed into potential energy by creating a depression. The magnitude of this depression is thus merely a measure of the energy which would have been available for scavenging purposes had an inlet valve been opened at the correct moment. A cycle can be visualised where a vacuum is actually produced in the cylinder and exhaust system of the engine, which is subsequently used to draw fresh air into the cylinder. There the time during which this vacuum is available would be of vital importance, but in the Kadenacy system, as explained above, this is not the case and the exhaust pipe dimensions only influence the requisite valve timing.

In conclusion, I should like to say that I have had the privilege, of which Dr. Mucklow has not yet availed himself, of seeing one of M. Kadenacy's engines in action without any exhaust pipe and that there was no doubt about a very powerful suction effect in the inlet manifold.

Yours faithfully,

Engineering Laboratory, Cambridge, April 9, 1940. S. G. Bauer, Ph.D.

The Drying of Frozen Foodstuffs.—Rapid freezing, with subsequent storage at low temperature, is probably the most effective way of preserving the desirable properties of foodstuffs. If, however, the moisture—present in the frozen foodstuffs in the form of ice—is removed by evaporation in a high vacuum, the dessicated products can be transported and stored without the need for refrigeration, and, in addition, there is a large saving of weight. In view of these possibilities, a small-scale plant, designed to dry foodstuffs at low temperatures, has been in operation at the Low-Temperature Research Station, during the past year, on behalf of the Food Investigation Board of the Department of Scientific and Industrial Research. Many different foods have been dried, such as fruit, vegetables, fruit-juices, meat, eggs, butter and milk, and it is stated that it is now clear that the products obtained are, in general, superior to those produced by other methods of drying. We are informed that interested British firms are invited to get into direct touch with the Superintendent, The Low-Temperature Research Station, Downing-street, Cambridge (Telephone: Cambridge 4477), who will be glad to give them further information. Application has been made for a patent to cover the process.

BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.

The annual report of the British Electrical and Allied Manufacturers' Association for the year ending December 31, 1939, was published last week. It records that during the year political considerations had an even more disturbing effect upon trading conditions than during the previous twelve months. The hope that economic collaboration might lead the way to agreement in the political field was shattered by the invasion of Czecho-Slovakia, and during the next five months there was some degree of conflict between the needs of rearmament and normal peace-time demand. After the outbreak of war it was inevitable that the necessary changes would result in dislocation, and it was not until the end of the year that the industry began to settle down under the new conditions.

General activity in the industry was at a higher level than in 1938, and there was an increase in employment. In July the number of insured persons in employment in electrical engineering, at 118,663, was 6·5 per cent. higher than in 1938, while in the cables, lamps and apparatus groups the increase was 7·3 per cent.; and in wiring and contracting, 1·8 per cent. At the outbreak of war the total effective labour force in the industry was over 340,000. In spite of rearmament demand, export business was maintained only a little below the 1938 record levels during the first eight months of the year. The actual decreases were 8 per cent. for electrical machinery and 6·5 per cent. for goods and apparatus. On the other hand, up to the end of August the export of generators was 20 per cent. greater than in the corresponding period of 1938 and 85 per cent. higher than for 1937. The transition from peace to war was accompanied by the imposition of numerous controls, though the difficulties caused by these have since lessened. A serious fall in the load on electricity supply systems was noted, but it is anticipated that readjustments will undoubtedly follow in time, coupled with an increasing tempo of industrial production on work of national importance. The demand for electrical plant for industrial undertakings was very high, and may well become greater. A higher industrial load may also stimulate the demand for generating plant.

Another factor affecting the industry in a number of ways is the conflict between saving and spending, and since much of the industry's trade is the result of the replacement of older, less efficient, apparatus, the problem is often to balance present capital cost against future economies. The need for economy has already affected the industry through restriction of the borrowing powers of supply authorities and through the suspension of railway electrification schemes. The importance of foreign exchange is such that export trade has assumed a special prominence. Nevertheless, there is a tendency to overlook the fact that exports depend upon an active home market. If there is a reasonable prospect of securing export business, it will be necessary to continue to supply home requirements in order to maintain production for the export market. The demand from the latter is likely to be good, since the countries which buy from the electrical industry are mainly producers which will benefit from war conditions. Another helpful factor is the elimination of German competition outside Europe. Against this must be set increased competition from local industry and from neutral countries. In meeting this, however, the United Kingdom has not been faced with any great differences between the prices of materials here and abroad. Shipping problems and other difficulties affecting manufacture may tend to raise British export prices, but neutrals also have their hardships and the depreciation of sterling offsets some of their advantages. In the Empire, neutral competition may be lessened by the need to conserve the supplies of foreign exchange and in many other markets substantial British purchases may be used as an argument for seeing that their imports are obtained from the United Kingdom.

In a supplement, it is noted that a special committee of the Association to deal with export matters was set up in November, and that the economic and statistical section was strengthened to cope with the increasing pressure of work. In January, contact was made with the Export Council, and two committees dealing with electrical machinery and with electrical goods and apparatus, respectively, have been set up. On September 1 the export of generators, switchgear and transformers was prohibited, except under licence. Considerable confusion and dislocation followed, owing mainly to the immense amount of work suddenly imposed on the department, and the lack of definition of the types of equipment. The services of the economic and statistical section were offered to assist matters, and by the end of the year the control was working smoothly and efficiently.

The report deals briefly with the other activities of the Association. These included representatives to Government Departments on the question of abnormal profits, standardisation and education. Regarding the last of these, the number of overseas students employed in members' works during the year was 256, compared with 262 in 1938, India again providing the largest quota. The *News Sheet* was of special value in acquainting members with war-time regulations, and since the war it has been circulated to other bodies. Reference is made to the work of the Association of Short-Circuit Testing Authorities, the Electric Light Fittings Association, and the Electrical Research and Electrical Development Association, with all of which co-operation is maintained.

"MONITOR" PRESSURE AND TEMPERATURE ALARMS.

The illustrations on the opposite page show, in Fig. 1, a compact device for giving both an audible and a visible alarm when the pressure in the lubricating-oil or cooling-water system of an internal-combustion engine falls below the safe operating limits, and, in Fig. 2, a similar device which operates when the temperature of these, or other, systems, rises above the desired level. The alarms are manufactured by Messrs. "Monitor" Patent Safety Devices, Limited, King's-road, Wallsend-on-Tyne. The group shown in Fig. 1 can be fitted to any existing standard oil engine by connecting the cocks seen below the pressure gauges to the supply pipes of the oil and water, respectively, and by connecting a two-core cable from the engine-room lighting circuit to the right-hand side of the rectangular box at the base. A similar cable, at the left-hand side of the box, connected to a Klaxon horn, completes the installation. Although the actual alarm is thus electrically actuated, the actual method of its operation depends upon the movement of diaphragms under the variations of pressure of the water or the oil. There are no electrical devices in the pressure gauges, which simply indicate the pressure on the systems. The oil and water supplies do not pass through the alarms, the connections to the cocks, previously referred to, being shunts from the jacket-water manifold and from the lubricating-oil manifold. The cocks are labelled "Keep Open" as shown, this being the operating condition. They are provided for testing purposes while the engine is running. When the alarm operates, the pressure on the gauge should be the same as that indicated by the pointer of the range scale.

The alarm range can be arranged to suit the systems concerned and, moreover, is variable, by means of the handles seen below the bottom box. In the particular installation illustrated in Fig. 1, the alarm is set to operate at a pressure of 20 lb. per square inch (1·5 kg. per square centimetre) for the lubricating oil, and at a pressure of 10 lb. per square inch (0·703 kg. per square centimetre) for the cooling water, the adjustable range in both cases being between zero and 30 lb. per square inch. The respective pressure gauges have a wider range for working purposes, *e.g.*, that for the lubricating oil is graduated to 80 lb. per square inch; since, when starting up from cold, the pressure may be considerably in excess of the normal working pressure. The working of the alarm may be best understood from the diagrams of Figs. 3 and 4. In these, the correct working pressure for both systems has been assumed to be 20 lb. per square inch, though, naturally, this pressure will vary with different installations and conditions of working, a greater supply of both cooling water and lubricating oil being required, for instance, in a hot climate than in a cold one. The horizontal scale of the diagrams is a time basis. The cooling-water circuit is indicated in Fig. 3. The alarm pressure is taken to be set at 15 lb. per square inch, *i.e.*, 5 lb. per square inch below the normal working pressure. The dotted line at 10 lb. per square inch merely illustrates the pressure set up by the static head, which may exist when the cooling-water pump has just stopped, the head assumed in this case being 23 ft. In many cooling-water systems there may be no flow at all through the cylinder jackets, even though a substantial pressure is showing on the gauge. The correct alarm pressure lies between the pressure of the water when the pump is delivering its maximum capacity and when the pump has just stopped.

In Fig. 3, the first alarm is given by the pump stopping when the water pressure falls suddenly and the electrical circuits of the device are affected. The dome at the right of the base in Fig. 1 is a white signal light, which shows as long as the engine is running. The fall of pressure referred to above switches off this light and switches on a red one in the dome in the centre of the base, the Klaxon horn being sounded at the same time. Re-starting the pump causes a return to the normal working pressure as shown in Fig. 3. The second alarm is provided for the event of the pump losing its suction. The pressure fall in this case is more gradual, but the alarm functions as before when the set pressure is reached and restoration takes place when the pump trouble has been remedied. In Fig. 4,

PRESSURE AND TEMPERATURE ALARM APPARATUS.

MESSRS. "MONITOR" PATENT SAFETY DEVICES, LIMITED, WALLSEND-ON-TYNE.

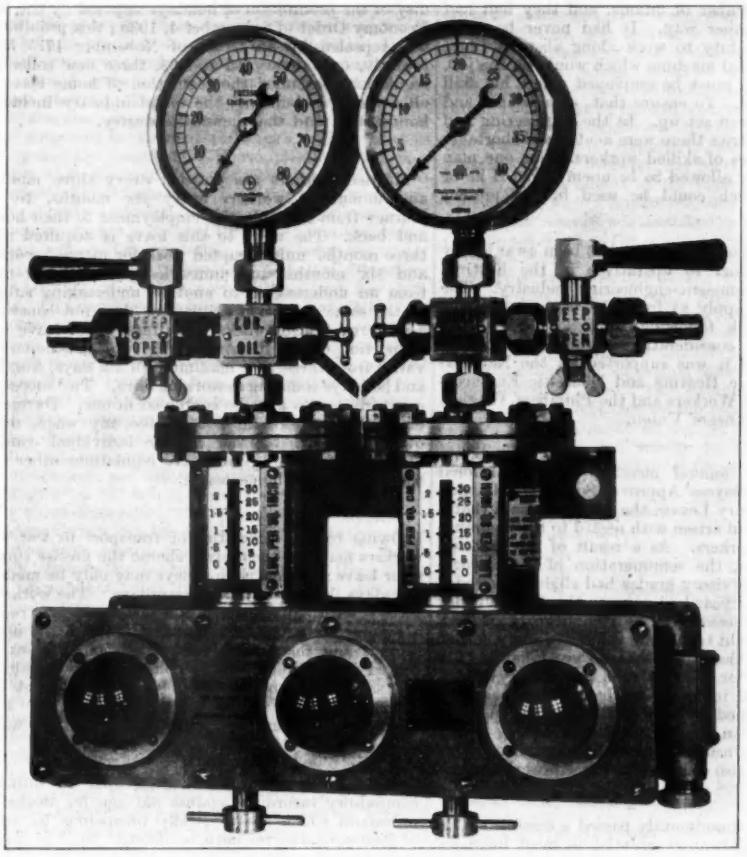


FIG. 1. COMBINED OIL AND WATER-SUPPLY ALARM.

Fig. 2.

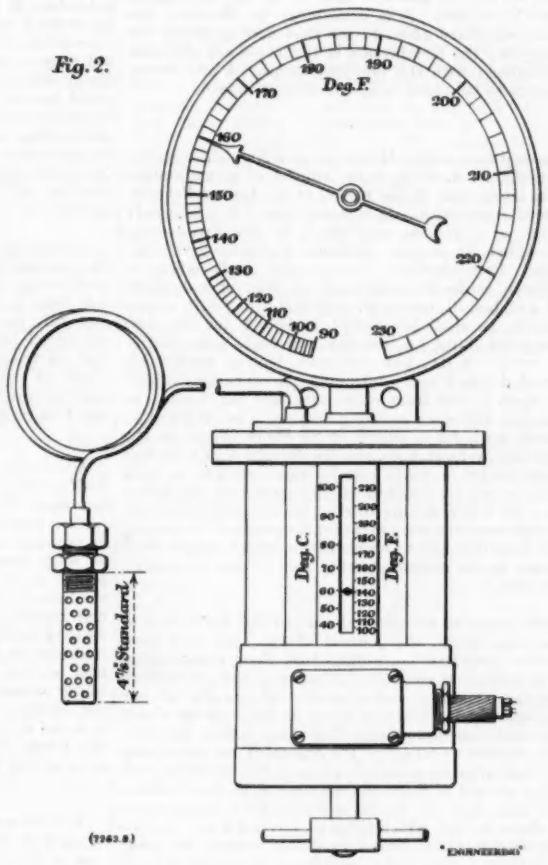


Fig. 3. COOLING-WATER

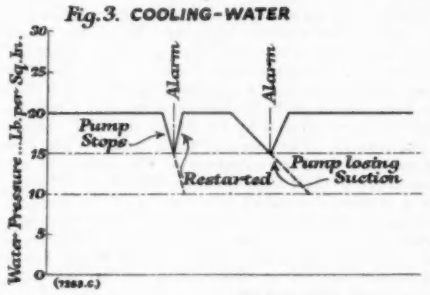
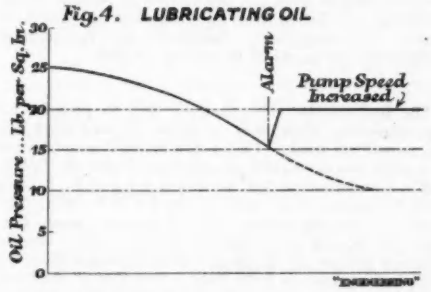


Fig. 4. LUBRICATING OIL



imaginary conditions for the lubricating-oil systems are shown. The normal working pressure is assumed to be 20 lb. per square inch, the set alarm pressure as 15 lb. per square inch, and the danger pressure as 10 lb. per square inch. The pressure curve starts above the normal working value, as a starting-up condition, when the oil is cold and viscous, is taken, and more pressure than the normal is needed to force the required amount through the bearings. As the oil warms up, however, it becomes thinner and the pressure falls gradually. This fall is shown in the diagram and continues until the alarm pressure is reached. The device then functions by the extinction of the white light at the left-hand of the base, the glowing of the red central light and the sounding of the Klaxon horn. The pressure is then restored either by partially closing the by-pass valve on the oil delivery pipe or by increasing the speed of the pump if this is independent of the engine. In the unlikely event of a defect developing in both the oil and water systems simultaneously, both white lamps will be extinguished. When a defect has been signalled and recognised, the current may be switched off, the horn being then stopped and all the lights being extinguished.

The temperature alarm shown in Fig. 2 is a modification of the pressure alarm and employs the diaphragm principle with electrical operation of the signal lamp and horn. A metallic diaphragm is employed, the upper surface of which is connected to a bulb, containing a syphon pipe and a sensitive fluid, by an armoured copper capillary tube. A dial thermometer above the diaphragm is graduated to a maximum of 230 deg. F. The range scale is graduated from 100 deg. F. to 210 deg. F., with corresponding Centigrade readings. Temperatures below 90 deg. F. are not provided for on the dial thermometer, as the fluid in the bulb has a boiling point of 95 deg. F. at sea-level and atmospheric pressure. The electrical connection consists of a three-core cable, one wire serving the alarm, another the signal lamp, and the third being the feeder. Normally, the alarm is arranged to signal the approach to too high a temperature, but can be altered to signal a fall in temperature below a desired limit by reversing the two first-mentioned cable-core connections. The instrument is made with two diaphragms for use where the temperature range must lie between high and low limits.

The thermostatic alarm can also be used, by means of suitable relays, to stop and start power plant. It can be fitted in any suitable position provided that the bulb is vertical and is, preferably, in the same horizontal plane as the diaphragm, in order to avoid possible error due to head of the fluid in the tube. The alarm device, while primarily designed for oil-engine-driven generating plant on board ship, can be readily adapted for other purposes; thus the pressure type can be fitted to energise, through relays, an electro-magnetic valve on the fuel-supply pipe of an unattended land engine, when it will automatically stop the engine in the event of failure of either the cooling-water or lubricating-oil pressure. It is claimed, moreover, that its compactness renders it suitable for use in confined spaces, such as may be found in the engine-rooms of small internal-combustion engined craft.

SUMMER COURSE IN MANAGEMENT IN THE UNITED STATES.—The State University of Iowa, United States, is organising a special course on "Management," intended for persons interested in comprehensive training in motion and time study, the elimination of waste, the reduction of costs and related subjects. The course, which occupies three weeks, from June 10 to 28, will be under the direction of Professor R. M. Barnes, who occupies the Chair in Industrial Engineering in the University, and he will be assisted by a number of University instructors and lecturers, and by visiting industrial managers and engineers. The course was held last year for the first time, and was attended by executive officers and engineers from 25 different industries in the United States and Canada.

STEEL FOR MOTOR VEHICLES.—The Ministry of Transport announces that manufacturers of motor vehicles, accessories and components should inform the Society of Motor Manufacturers and Traders, Hobart House, Wilton-street, London, S.W.1, not later than April 30, if they require steel for the quarters ending September 30, 1940, and December 31, 1940, for the construction and maintenance of vehicles of the following types, namely, (*a*) public-service vehicles (including omnibuses, coaches, and trolley vehicles, but excluding trams); (*b*) goods vehicles; (*c*) trailers; (*d*) private cars; and also for spare parts and service. It should be stated under each category whether the requirements are for home civilian use, for export, or for both. In the case of electric-battery vehicles and components, the information should be sent to the Electric Vehicle Association of Great Britain, Limited, 2, Savoy-hill, London, W.C.2. It is emphasised that applications received after April 30 cannot be considered.

LABOUR NOTES.

The April issue of the *Review* of the United Patternmakers' Association states that "trade continues very good." In March, the number of unemployed members decreased from 64 to 60, the number on sick benefit from 594 to 369, and the number on superannuation from 675 to 669. It is gratifying, Mr. Findlay, the general secretary adds, to see that new members are coming in; the membership is 12,293—a net addition, as compared with the previous month, of 52. Fifty-eight are to be added, it is stated, next month.

An addition to the Overtime and Nightshift Agreement of July 6, 1922, is the subject of memorandum in the latest issue of the *Review* of the United Patternmakers' Association. It is stated that "it is mutually agreed, as a general principle" by the Engineering and Allied Employers' National Federation and the United Patternmakers' Association that, where a workman works the full hours or more of a dayshift and a nightshift, or a nightshift and a dayshift, consecutively, he shall be allowed to lie off for the two subsequent shifts, *i.e.*, the day and night following, or *vice versa*. A dayshift workman, having worked his normal dayshift and continuing the work throughout the night (apart from meal intervals) till 6 a.m., or later, the following morning, shall not be required to resume work for a period of 24 hours except in the following circumstances, viz. (*a*) when he works through Friday night, in which case he may continue to work until the normal dayshift stopping time on the Saturday; (*b*) when, having worked his dayshift, he works the nightshift the same night for the purpose of changing over from dayshift to nightshift, in which case he shall resume at the normal starting time of the succeeding nightshift."

The writer of an editorial note in the April issue of *Man and Metal*, the journal of the Iron and Steel Trades Confederation, admits that there is something to be said for the argument that everything should be done to conserve and increase the surplus of the Unemployment Insurance Fund in anticipation of any large-scale unemployment that may follow the war. But, he goes on to say, "the argument has point only for those who are prepared to leave the problems with which we will be faced at that time to be dealt with as they arise and who regard as inevitable a similar state of affairs to that which followed the last war. Anyone who thinks that the workers of this country are going to submit meekly to a repetition of what happened after 1920 with wages tumbling and unemployment mounting sky-high will have a rude awakening."

"We can build up our surplus in the fund as much as we like and make it as strong as possible," the contributor of the note continues, "but it will soon be wiped out by an avalanche of four to five million unemployed. Neither will the workers be content to accept the empty promises so lavishly made after the last war, and will certainly not be put off with the same facile explanations a second time. For this reason, the executive council considers it vital that this problem should be faced now, and that steps should be taken immediately to set up a representative and authoritative body charged specifically with the task of industrial re-adjustment due to the change-over from war-time conditions to those of peace."

When the House of Commons went into Committee of Supply on Tuesday last week, an interesting discussion took place on the Vote for the Ministry of Labour and National Service. In the course of it, Mr. Ernest Brown, the Minister of Labour and National Service, said that men who six months ago had little hope of employment were now being rapidly absorbed. In the mustering of man-power he included women. The Government had prepared an estimate of the problem of man-power, which included women, for at least 18 months ahead. That, of course, was secret. They had taken the employers and workers in the industries into full confidence with regard to the means by which the necessary labour force for war production could best be secured. The employers and trade unions had expressed their readiness to help, both by advice and by practical action. The Ministry had set up sub-committees to maintain practical co-operation between the Government and the engineering and shipbuilding industries. There had been a growth of efficiency in the employers' organisations and in the trade union organisations, and greater co-operation than in any previous period. No one should advocate "repugnant steps" until they had exhausted to the full the co-operation between employers' organisations and the trade unions. That was the way in which to get results.

In the engineering industry, the Minister said, an agreement had been arrived at, and where breaches of it were brought to the notice of the responsible parties, either employers or employed, they were being dealt with. The case was not the same in the shipbuilding industry, because there they were dealing with a federation of a number of unions, and they had had to proceed in another way. It had never been his conception of his duty to work along abstract lines, but to get a practical machine which would do the job. Every skilled man must be employed where his skill could best be used. To ensure that, area boards and committees had been set up. In the engineering and shipbuilding industries there were acute local shortages in particular classes of skilled workers. Not one man or woman must be allowed to be unemployed if he or she had skill which could be used in the present emergency.

A wage increase of 1*d.* an hour has been awarded by the Industrial Court to operatives in the heating, ventilating and domestic-engineering industry. The new rates are to apply as from the beginning of the first full pay week following April 12. The claim submitted for the consideration of the Court was for 1½*d.* an hour, and it was supported by the National Union of Operative Heating and Domestic Engineers and General Metal Workers and the Plumbers, Glaziers and Domestic Engineers' Union.

Addressing the annual meeting of the National Federation of Employees' Approved Societies in London last week, Mr. Henry Lesser, the president, said that a curious position had arisen with regard to the insurance of non-manual workers. As a result of war bonuses or wage increases, the remuneration of some workpeople in the supervisory grades had slightly exceeded the limit of 250*l.* a year laid down in the Act, and they had consequently ceased to be compulsorily insured. As they had the right to become voluntary contributors, it might be said that there was no great hardship in this, were it not for the fact that a voluntary contributor whose total income exceeded 250*l.* a year was not entitled to medical benefit. Thus the position resulted not only in the insured person having to pay the whole of the insurance contributions himself, but in depriving him also of the right to medical treatment.

The federation unanimously passed a resolution that temporary war allowances granted to meet increased cost of living should be disregarded for the purposes of National Health Insurance and called upon the Minister of Health for amending legislation to exclude such war bonus payments from the calculation of remuneration. A further resolution was adopted that the limit of income for compulsory insurance for non-manual workers should be raised from 250*l.* to 400*l.*

The text of the Government's Bill to provide for supplementary allowances to certain injured workmen was issued last week. Under it, a married man entitled to weekly payments and in accordance with the Workmen's Compensation Act, will receive up to 5*s.* a week extra in respect of his wife and 3*s.* for each child. The total of compensation and allowances must not, however, exceed seven-eighths of the average weekly earnings before the accident. It is intended that the Bill shall operate as from July 1 and that it shall not apply to any case where the accident happened before January 1, 1924.

In view of the judgment of the House of Lords in the case of Mr. Arthur Pratt, the shop assistant, who recovered 397*l.* 10*s.* in respect of meals supplied to him by his employer as part of his wages, the Government, it is stated, intends to introduce a Bill amending the Truck Act. Under Section 4 of the Truck Act of 1931, a workman is entitled to recover from his employer the amount of any wages not paid to him in coin of the Realm. If the change takes place, the position will probably be that an employer could be sued for breach of the provisions which limit his powers to make deductions from wages but that the worker could not recover amounts wrongfully deducted. In announcing the Government's decision, Sir John Anderson said that a number of workmen's claims had already been lodged to recover wages which had been paid in the form of food and other things.

Many workers have been mobilised for employment in Germany in industries of special importance in the prosecution of the war, with the result that most of them are separated from their families. The problem of ensuring to them regular home leave has accordingly arisen (*Industrial and Labour Information* says), and the authorities have taken the view that an effective guarantee should be given them in this connection and inserted in the general conditions of employment. From October 12, 1939, collective agreements settled the question for those employed on public works, and on November 7, the minister of Labour issued an Ordinance declaring that the rules laid down for that industry must be followed for all the other branches of activity. These measures were taken during the validity of the prohibition of holidays imposed by the War Economy Order of September 4, 1939; this prohibition was repealed by an Order of November 17. More recently, on January 15 and 23, three new collective regulations extended the regulation of home leave to all workers in building, the metal industry including handicrafts, and the chemical industry.

Married workers are entitled every three months, and unmarried workers every six months, to the journey from their place of employment to their homes and back. The right to this leave is acquired after three months' uninterrupted work for married workers and six months' for unmarried workers; transfer from an undertaking to another undertaking subject to the same collective regulations does not constitute an interruption of work. The duration of leave is in proportion to the distance of the worker's home; it varies from three to a maximum of six days, Sundays and holidays counting as working days. Two successive quarterly leaves may be combined in one. During his leave the worker will not receive any wage, unless otherwise decided either by the individual contract of employment or by collective regulations other than those governing home leave.

Owing to the difficulties of transport in war-time, workers may not themselves choose the precise time of their leave; moreover, journeys may only be made on Tuesdays, Wednesdays and Saturdays. The worker on leave is entitled to a third-class ticket and may receive a refund of the costs of transport between the undertakings and the nearest railway station. Aliens employed in the undertakings concerned are entitled to the same leave but will receive free transport only within Germany or as far as the frontier. These regulations will remain in effect throughout the war.

The Japanese Cabinet has decided to introduce compulsory insurance against old age for workers in industries which are especially prosperous by reason of their activities for national defence, such as the iron industry, the machine and tools industries, the chemical industry, mining, etc. The proposed measures are intended, at the same time, to absorb the purchasing power of the population with a view to avoidance of inflation, by means of compulsory contributions, and to provide for workers' protection by giving a certain security to the lives of workers who have retired, and preparing to meet the unemployment which may result from demobilisation. Compulsory insurance for seamen was introduced at the last session of the Diet; this insurance is administered by the State and is so conceived that seamen, after working for a specified number of years and paying contributions amounting to about one-tenth of their wages, will be entitled, on retirement, to a pension equivalent to a quarter of the wage. The insurance which the Government now proposes to introduce is in some way the extension of the seamen's system to industrial workers. The State will pay subsidies and the employers and insured persons will pay equal contributions.

Under an Order issued by the Municipality of Tehran, wages in the building industry there have been fixed for the period ending the Iranian year 1319 (March 20, 1941). This is the first time that wages have been fixed in any branch of industry in Iran. Under the Order, workers employed in the industry in question are divided into 42 different classes, comprising not only builders but architects, smiths, carpenters, painters, glaziers, etc. Maximum and minimum wages are fixed for each class of workers. The maximum wages apply to the first eight months of the Iranian year, from March 21 to November 21. For the other four months, which include the winter, the minimum wages will take effect. Both summer and winter wages have a maximum and a minimum also, according as the worker concerned is skilled or unskilled. The wages thus fixed vary between a maximum of 45 rials for a master mason and a minimum of 8 rials a day for a stone-breaker. At the present rate of exchange, 67·75 rials equal 1*l.* sterling.

The Roumanian Petroleum Industry.—The production of petroleum in Roumania totalled 6,250,000 metric tons in 1939, compared with 6,610,000 tons in 1938, 7,153,000 tons in 1937 and 8,394,000 tons in 1936.

PERMANENCE OF THE PHYSICAL PROPERTIES OF PLASTICS.*

By J. DELMONTE.

IN the examination of the permanence of the physical properties of organic plastic materials, attention should be given to those operation conditions which are likely to produce changes in the materials. When these operating or service conditions have been analysed, they should serve as a basis of comparison for the various plastics. As engineering materials, one of the most singular characteristics of organic plastics is their response to thermal influences. They are, in fact, generally classified as thermoplastic or thermosetting, thus distinguishing between materials which are profoundly influenced by heat and those which are only slightly affected. Another characteristic of plastics which has a decided influence upon the design and application of the materials, is their behaviour under applied stresses. A review of technical literature indicates that, with certain exceptions, very few data useful for engineering purposes are available on the creep and cold-flow characteristics of the various plastics. Variations in test methods; examination confined to one material; failure to stress the material for a sufficient length of time; and failure to report fully the nature of the molecular structure, composition, or previous history of the material, are some of the reasons detracting from the value of the researches. Plastic materials, more so than many other materials of construction, are subject to permanent deformation under stress and, hence, require systematic analysis along these channels.

The media in which the plastic materials are operating may also have a bearing upon their properties. Particularly noteworthy are such influences as the actinic rays of sunlight, high humidity, and the corrosive effects of chemicals, any of which may cause a loss in utility of the materials. When the material is to be used in a severe corrosive medium, tests in that specific medium under the most rigid operating conditions are usually conducted by the organisation contemplating the use of the material. Only in that manner can it be ascertained whether the material will prove acceptable in service.

Consequently, in examining the permanence of the physical properties of plastics, the following tests may be pursued to evaluate the relative merits of the plastics: Firstly, creep and cold-flow tests at various stresses and at various temperatures, for different lengths of time, should be carried out. The recovery upon removal of stress should also be observed. Secondly, the properties of organic plastics at elevated temperatures, and their properties after return to room temperature, after exposures for different periods of time, should be studied. Thirdly, the effect of immersion in water, or high humidity, upon the properties of organic plastics should be studied. Instead of water, corrosive chemicals may be employed.

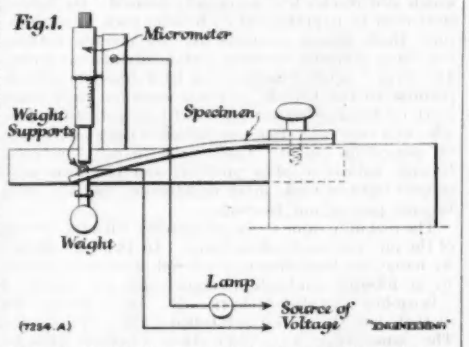
Creep and Cold-Flow Characteristics.—In this paper, an analysis will be made of the creep and cold-flow characteristics of solid plastic materials, as they are available commercially, in sheet form. The need for data of this nature has been emphasised in recent years. Standard compression and tension tests must be modified to take into consideration time and temperature, because organic plastics, besides exhibiting elastic deformation, exhibit a time-dependent plastic deformation. There has been some doubt as to when plastic deformation first begins to make its appearance when the stress is slowly applied to the material. It has been suggested recently, by R. Houwink, that for solid organic plastics, every stress will produce a certain amount of plastic deformation. The results of the present investigation show this to be the case for a number of plastic materials, even down to very low values of stress.

Many of the researches upon the plastic deformation of amorphous materials have employed methods designed to give uniform tensile or compressive stresses within the test materials, under uniform loading conditions. For example, some tests compare plastic materials on the basis of the percentage change in height of a small cube under a predetermined load at 120 deg. F., over a period of 24 hours. This technique is also employed in the mechanical testing of rubber, where dead weights are applied for certain periods of time on rubber samples. Other quite common methods employ ball-and-needle penetrometer techniques under certain loads at certain temperatures, for various time intervals. It has been the author's experience that such methods are particularly adaptable to materials which exhibit relatively large deformation for a given tensile or compressive stress. These materials would include those plastics which have been described as possessing rubber-like qualities such as plasticised polyvinyl acetals, plasticised polyvinyl chlorides, rubber-like alkyds, certain acrylic resins, etc. When the more solid materials of this investigation were examined under direct tension and compression, however, the time for appreciable plastic deformation to take place was very long, lessening the accuracy of the readings, and making it difficult to distinguish the various stages of plastic deformation.

Another procedure followed in observing creep phenomena is to load and unload materials within the proportional limit of the stress-strain curve, measuring the creep as a function of the elastic-hysteresis loop; this technique is important also in determining Poisson's ratio. However, the method does not permit a study of the effects of the time duration of stress, which is so highly important to plastic deformation, and is not readily adapted to the study of recovery phenomena, such as the elastic after-effect.

In this investigation samples of the plastic materials were supported as simple cantilever beams and loaded by dead weights at the end. The apparatus designed by the writer, a diagrammatic sketch of which is given in Fig. 1, on this page, tested four samples simultaneously, making it possible to observe materials under four different maximum fibre stresses during the same period of time. The equipment was enclosed within an insulated chamber, thermostatically controlled with air circulation, to 85 deg. F. ± 2 deg. F. Four micrometers attached solidly to the support block measured the end deflection of the specimens by electrical contact with the support for the weights, and completing the circuit with a 7·5-watt lamp placed in series. The micrometers were operated manually when readings were to be taken. The load applied by spring-actuated dial gauges was too great to permit them to be used in these tests. The supports for the weights were reduced to a minimum, weighing only 4 grammes. The micrometers were read when contact was made with the weight support, which was indicated by the lighting of the lamp. The readings were accurate to ± 0·0003 in. The specimens were retained at their ends by ⅛-in. steel pieces, clamped down by two thumbscrews. In making stress calculations, the weights of the supports for the loads and the weight of the specimens were taken into consideration. Electrical connection to the weight support was made through a fine enamelled wire.

Fig. 1.



While the values of deformation observed are, in fact, an integrated value for all stresses up to the maximum fibre stress, a simple cantilever beam affords a simple method of ascertaining the elastic and plastic properties of materials. The simple cantilever beam has an advantage over other types of beams, inasmuch as its moment diagram for loads at the end is a straight-line function of the suspended length, and also possesses a uniform shear diagram. It may be readily seen that the simple cantilever beam, by reason of its deflection at the end, acts as an amplifier of stress deformation in its fibres, in a ratio of some function of the length to the thickness of the material. There is much precedence for the use of a deflection of a beam as a measure of flow in solid bodies. Trouton* investigated flow in rods of pitch under the methods of tension, compression, and bending. His curves for sagging as a function of time show a distinct exponential relationship. In a majority of these earlier instances, tests were conducted upon bituminous substances or concrete, whereby the test specimens were placed upon two horizontal supports and deflection observed in the middle under the weight of the specimen or additional weights.

The deflection of a beam also serves as the basis of comparison for plastic materials in a heat-distortion test in an American Society for Testing Materials Specification† where the temperature is raised slowly and the temperature is noted at which a deflection of 10 mils occurs. In a similar British Standard Specification (No. 771-1938), a simple cantilever test beam is employed to determine what is referred to as "plastic yield." The plastic yield is described as the specified allowable maximum deflection for a 5 mm. by 5 mm. specimen, 150 mm. long, at a certain temperature.

Materials Tested.—The following five materials (*a*) to (*e*) were included in this investigation and a comparison made of their relative deformation as a function of time, for various stresses induced in the materials when they were loaded as simple cantilever beams. The specimen lengths were selected at 5 in., with the exception of polystyrene, which was 2·5 in. long. The results of polystyrene were corrected to a 5-in. length. The widths of the specimens were approximately 1 in. and, while an effort was made to obtain uniform thickness, the laminated phenolic and polystyrene samples differed from the others. (*a*) Cellulose-acetate sheet: Specimens were cut from clear transparent sheet stock, approximately 0·089 in. thick. (*b*) Polyvinyl chloride acetate: Specimens cut from a white, filled stock, 0·094 in. thick. (*c*) Methyl methacrylate: Specimens were cut from clear, transparent stock 0·09 in. thick. (*d*) Polystyrene: A flat injection-moulded test bar, 0·069 in. thick, served as a test sample. (*e*) Laminated phenolic sheet, canvas base, 0·065 in. thick.

Within certain stresses, the initial rapid deflection of the simple cantilever beam test specimens is a truly elastic deformation, the magnitude of the deflection and the maximum fibre stresses being calculable from the following well-known formulæ, which assume the validity of Hooke's law and the uniform distribution of stress-strain relations in compression and tension about the neutral axis

$$y_e\,(\text{max.}) = W\,\frac{L^3}{3}\,E\,I \qquad . \qquad . \qquad (1)$$

and

$$M = S\,\frac{I}{c} \qquad . \qquad . \qquad . \qquad (2)$$

where y_e = true elastic deflection,
W = weight supported at end of beam,
L = distance from point of support to weight
E = modulus of elasticity,
I = moment of inertia,
S = maximum fibre stress,
M = maximum bending moment = W × L,
c = distance from neutral axis to outermost fibre.

Immediately following the truly elastic deformation, the phenomena of creep and cold flow will commence, increasing the amount of deflection. Two stages of plastic deformation were observed for the materials under test: Stage A; the rate of change of deformation with time $\left(\frac{dy}{dt}\right)$ changes from a maximum to a minimum constant rate. Stage B, in which $\frac{dy}{dt}$ remains constant for an indefinite time for a given fibre stress (or given integrated stress value).

Unlike crystalline materials which may work-harden, whereby $\frac{dy}{dt}$ approaches zero, none of the plastics included in this test behaved in this way, even at maximum fibre stresses as low as 500 lb. per square inch. For the sake of definition, "cold flow" may be described as that constant rate of change of deformation with time which a material will exhibit after being subjected to a certain stress for a certain period of time at a constant temperature. In accordance with earlier suggestions, "creep" may be described as that stage of plastic deformation where the velocity of the deformation rate changes with time $\left(\frac{d^2y}{dt^2}\right)$. Creep experiences its greatest value following the elastic deformation, becoming zero when true cold flow finally occurs. From the data presented in this paper, it will be seen that considerable time elapses before creep becomes zero, depending upon the maximum initial fibre stress. In general, it was observed that the lower the maximum fibre stress, the sooner creep was terminated and pure cold flow commenced.

A general expression for plastic deformation may be developed in the light of creep and cold-flow phenomena. Assuming the two stages of deformation for amorphous materials, we have the following

$$y\,(\text{total}) = y_e + y_p \qquad . \qquad . \qquad (3)$$

where y_e = elastic deformation,
y_p = plastic deformation.

The elastic deformation is defined by Hooke's law within the elastic limit of the material:

$$y_e = \frac{S}{C} \qquad . \qquad . \qquad . \qquad (4)$$

where C = elastic constant,
S = stress required to produce y_e.

* Paper presented at the Annual Meeting of the American Society of Mechanical Engineers, held at Philadelphia, U.S.A., from December 4 to 8, 1939. Abridged.

* See *Proc. Roy. Soc.*, Series A, vol. 77, page 426 (1906).

† See Supplement to Book of A.S.T.M. Standards, D48-37, page 232 (1937).

Expressing y_p as a function of time and stress, the following formulæ may be applied

$$S = R V + M \frac{d V}{d t} \quad . \quad . \quad (5)$$

where

$$V = \frac{d y_p}{d t} \quad . \quad . \quad . \quad (6)$$

and M = coefficient of viscous impedance,
R = coefficient of internal resistance of molecules.

As a solution to equation (5), we have the following expression for V, which is the rate of plastic deformation with time

$$V = \frac{S}{R}\left(1 - e^{-\frac{Rt}{M}}\right) \quad . \quad . \quad (7)$$

When t becomes very large, V is equal to the cold, flow

$$V = \frac{S}{R} \quad . \quad . \quad . \quad (8)$$

Integrating equation (7), we obtain an expression for the plastic deformation as a function of time

$$y_p = \frac{S\,t}{R} + \frac{S\,M}{R^2}\left(1 + e^{-\frac{Rt}{M}}\right) \quad . \quad (9)$$

From the general solution for plastic deformation as a function of time at constant temperature, it is possible to make the necessary corrections in the calculations of beam deflections.

In spite of the dual nature of the strain characteristics of the plastic materials, whereby one portion of the molecular structure exhibits true elastic deformation, and the other portion is susceptible to plastic deformation even at the smallest stresses (these effects are evenly distributed throughout the structure), we can with justification employ the straight-line portion of the stress-strain relationship to determine the modulus of elasticity under certain conditions. These conditions demand a short-time loading of the material, and the existence of an elastic deformation considerably in excess of plastic deformation (which was true for most of the materials tested). On the other hand, when time or permanency is a factor, modifications must be made in accordance with the general relationship established for plastic deformation, which is also verified by the experimental results of this paper.

(To be continued.)

OIL.*

By F. Heron Rogers, M.I.Mech.E.

To-day, as your President, I have deliberately chosen the subject of oil, as I am firmly of the opinion that in the years to come the entire development of this great necessity of the human race will eventually pass into the hands of the chemist and chemical engineer. Let it be understood that when one says "oil" it means all the fractions of that hydrocarbon body, whether they be gaseous, liquid, solid, mineral or synthetic. Let us pause here for a moment, to traverse the history of our subject, to feel its pulse so to speak, and then to ascertain to what degree we are dependent upon oil and, in its absence, the measure of the problem that is with us, and particularly in Great Britain at the present time. In looking at our own problems it is necessary to be informed of the world's demands for this material and perhaps weigh, and later perhaps appreciate, its political, financial and industrial significance.

Much has been written and said of the origin of mineral oil and its geological occurrence, and it is not the aim of this address to dip deeply into those realms of fact or speculation. It is, however, amply evident that subterranean heat and pressure in the crust of the earth have acted to distill or cause molecular change in the sunken deposits of prior vegetable life on the earth's crust, and the ideal location or field for oils is that wherein a permeable oil stratum occurs with an impermeable cover. To track unknown oil beds one calls into play all available knowledge—geology, surface structures and carboniferous association—using geophysical tests for subsoil formation and comparing geologic sequence, fossil occurrence, and then finally using the drill, in many cases to prove the barrenness of every well-meaning augury.

The story of mineral oil use goes back to the earliest times, long prior to those of any tangible human record. Its occurrence at Ur in Mesopotamia dates from 2000 B.C. Bitumen was used by the Egyptian craftsmen as an adhesive layer in which to embed their furniture inlay. Fine specimens of this art were found in Tutankhamen's Tomb at 1354 B.C. Herodotus refers to the existing oil pits at Ardericea near Babylon, and the pitch springs of Zante. Plutarch refers to the petroleum found near Kerkuk. Gas springs were used for lamp jet illumination in Italy in 1226. In the thirteenth century, Marco Polo referred to the oil springs of Baku. The oil of Pechelbron was known in 1498. Sir Walter Raleigh described the pitch lake at Trinidad in 1595. In the Seventeenth Century, Thomas Shirley notified the Royal Society of natural gas in Shropshire. In 1748, the oil springs of Pennsylvania were mapped, and also about this time the Rumanian oil lands were described by Raicevitch.

Until 1850, mineral oil as such was not developed at all commercially; its recognition had been tardy, and its domestic use generally accompanied by smoke or smell, or both, and curiously enough its possibilities did not stimulate research. At the advent of the oil industry, paraffin was the desired product, its use as an illuminant outstripping commercially the lighter and the heavier hydrocarbons then used as solvents, lubricants, petrolatums or the semi-solid products, waxes and asphaltes. Oil lamps were in vogue, and that era between the tallow or wax candles and electric light produced the incubation period of oil development, the residue, after paraffin, finding its legitimate mark in lubricants, and in a much less degree as fuel. The lighter ends embraced the material known as naphtha, used largely towards the end of the paraffin period as a solvent. The material known as petrol, gasoline, or benzine (depending upon the country in which you reside) was practically unused; its lighter ends went to naphtha and its heavier ends to paraffin, since these named products are not definite entities but those accruing between certain distillation limits. The term "petrol" indicates a light fraction, a term peculiar to the British, and was invented as a trade mark by Messrs. Carless, Capel and Leonard, of London, who, at a very early date, specialised in the manufacture of petroleum spirit. Later, the name "petrol" became indicative of a product, and the firm were refused right of trade mark registration, and the word became part of our language.

The real fillip came to the oil industry with the advent of the internal-combustion engine. In 1885, one Butler by name, an Englishman, produced a tricycle driven by an internal-combustion engine using the vapour of "benzoline" exploded electrically. In an illustration of that date the device is labelled "the petrol cycle." The same year, *i.e.*, 1885, Herr Gottlieb Daimler invented his internal-combustion engine using petroleum spirit, and, curiously enough, the French nation did the majority of the immediately later development of this engine for road use. Daimler attached his engine to a cycle as did Butler, but he also placed one of these engines in a boat which traversed the Seine in Paris at the time of the Paris Exhibition of 1889.

The engines of the early motor-car builders employed a petroleum spirit of light gravity, naturally distilled, and for that reason did not give a very high compression to their engines, the compression ratio being in the neighbourhood of 4 to 1, otherwise pre-ignition resulted and the engine back-fired. Back-firing in those days was associated with the difficulty of starting up and, although the benefits of higher compression and consequent increase of power were then recognised, the question of fuel modification was shelved, and the mechanical part of propulsion proceeded apace.

The motor-car industry became world wide in development and the race for improvement, international. The early work of Sir Dugald Clerk, prior to the war of 1914, and the later work of Ricardo, both experimenting in this country, paved the way for recognition of what is now known as the H.U.C.R.—the highest useful compression ratio. Ricardo designed a variable-compression engine, and from this determined the compression ratio for any given fuel; that is to say, the degree of compression which gave the maximum power without pre-ignition under continuous engine running conditions. The results of these tests were given just after the last war, but the ratios of any given fuel varied too much with the type of engine used, and in 1922, Midgley and Boyd used a bouncing pin to measure detonation, the pin resting on a diaphragm in the cylinder combustion head, and recording its duration of movement electrically. During the work of the two latter experimentalists many varieties of fuel fractions were used and they discovered the value of lead tetra-ethyl as an anti-knock dope. The Fuel Research Committee of America, in seeking for a criterion of engine knock point or H.U.C.R., decided, in 1929, to adopt the suggestion of Graham and use iso-octane and normal heptane as standard fuels, the H.U.C.R. value of any fuel being a comparison with the octane number which amounts to the percentage by volume of iso-octane in a mixture of octane and heptane, having the same knocking tendencies under standard test conditions as the fuel for comparison. If one looks back retrospectively, say to 1900, the octane value of straight-run spirit was 58/59 and the compression ratio 4-4½ to 1. To-day, the octane number of aviation spirit is 87-100 and the compression ratio 9 to 1.

Cracking.—In the early days of the entry of the motor car into daily life, it was obvious that the light fractions of crude-oil distillation would soon be insufficient for the needs of industry, and many minds were applied to obtain a greater yield of light spirit from heavier hydrocarbons and the neglected art of cracking was invoked in aid. James Young, of Glasgow, had demonstrated in 1865 that if a relatively heavy oil were subjected to heat and pressure, it would "crack," and from such relatively heavy oil, produce a fraction of light gravity. Young recommended a pressure of 20 lb. per square inch. Young, at the date of his discovery, was dealing with shale oils, and was many years in advance of the times; if the plant to embody his ideas had been put into production, solely for light volatiles, the output would have been mainly unsaleable. Nevertheless, we must, as indeed the scientific world, I am sure, does, recognise him as the basic originator of cracking. These cracking processes, generally speaking, at a considerably later date, came into vast vogue and remain so even to-day.

Benton, in 1886, in the United States, patented a pressure still in which the raw oil stock was heated from 700 deg. F. to 1,000 deg. F., and the pressure maintained at 500 lb. per square inch, the vapour evolved being liberated at a rate to maintain this pressure. Dewar and Redwood, in Great Britain, in 1890, patented a process that is much akin to modern methods, in that they heated the oil body and maintained the pressure either by the hot oil vapour or by inert gas under pressure in the oil heater, vapour chamber and condenser, their document remarking that "we obtain from a heavy residue a quantity of more or less light oil suitable for illuminating or other purposes which cannot be obtained by distillation under atmospheric pressure." Dr. William Burton, in 1913, in the United States, followed with a pressure still, and like Dewar and Redwood, constructed the outlet of pressure gas at the terminal end of the condenser. These stills had elevated condensing plants refluxing to the boiler, and this plant had a very considerable vogue in the United States and was well in its stride towards the middle of the great war.

Of cracking systems there are many varieties which, owing to the confines of this address, can only be touched upon very lightly. They may, for the sake of brevity, be divided into the following four main classes, namely: (*a*) pressure distillation; (*b*) vapour-phase cracking, wherein high temperature may be employed without high pressure; (*c*) liquid-phase cracking wherein the oil is heated to, say, 1,000 deg. F., or in some cases above this, but kept by pressure in the liquid phase, and a time interval allowed for molecular change; and (*d*) catalytic cracking using both heat and pressure. This process admits of synthetic building.

The term "cracking" is, to my mind, not a very happy word. It is, however, an apt description to cover the double operation of decomposition and polymerisation. The amount of spirit produced depends very largely upon the raw-oil stock treated. In 1922, I had what our American friends call a "hunch" that the cyclic compounds would crack easily and yield in cracking a heavy proportion of the aromatic compounds with relatively high anti-knock properties.

In 1923, with vast difficulties, I took a barrel of Russian paraffin as personal luggage to Kansas, and the Drs. Cross gave me the free run of their laboratory in Kansas City where the hunch turned out to be correct, and with the aid of a financial partner, a "Cross" cracking plant was installed on the Medway during the same year, this plant being the first oil cracking plant in this country producing what was then named "Power" petrol. By studiously invoking the aid of motor cyclists and the racing fraternity, a lift was made in H.U.C.R. values which others had to follow. Thirteen years ago on the anniversary date of this meeting you will find a paper that I read dealing with the details of this plant.*

Let us examine the figures of oil, and oil for the United Kingdom in particular. The world production of crude mineral oil on the latest statistics is 270,000,000 tons. Only two of the larger countries of the world are really self-supporting in this commodity, namely, the United States and Russia. The percentages of these two countries to total production are, respectively, the United States 60·6 per cent. and Russia 10·5 per cent. Venezuela comes near to Russia at 10·3 per cent., but that country exports almost its entire output.

The United Kingdom, for the year 1938, imported 3,228,858,000 gallons of oil products and 40,500 tons of paraffin wax. In addition, it produced 98,000,000 gallons from coal and re-exported in oil fuel for steamers 313,204,000 gallons. Shales produced 33,600,000 gallons. Reducing these Board of Trade figures given in volumes to a more convenient measure by weight, and using average gravities for the purpose,

* Presidential Address delivered at the Eighteenth Annual Corporate Meeting of the Institution of Chemical Engineers, held in London on Friday, April 5, 1940. Abridged.

* *Trans. Inst. Chem. Eng.*, vol. 5, page 89 (1927).

we have an import of 4,875,000 tons of motor spirit and a home manufacture of 326,660 tons, making a total of 5,201,500 tons, that is 2¼ cwt. of spirit per head of our population. Taking the other importations, including crude oil, kerosene (paraffin), lubricants, gas oil, fuel oil and paraffin wax, the additional tonnage amounts approximately to 7¾ million tons, making a grand total, less exports, of 11½ million tons, or over a quarter of a ton per head of population.

(To be continued.)

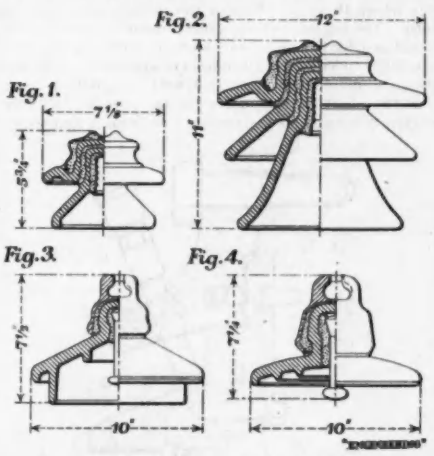
THE DEVELOPMENT OF A PRE-STRESSED GLASS INSULATOR.

A PAPER on "The Development of a Pre-Stressed Glass Insulator" was read before the Transmission Section of the Institution of Electrical Engineers on Wednesday, April 10, by Mr. P. M. Hogg. Pre-stressed, or toughened, glass, said the author, was glass which had been so treated after manufacture as to produce intentionally a strain distribution in which the surface layers were in a state of high compression. The pre-stressing process consisted in heating the glass to a uniform temperature considerably above its strain temperature and then cooling it rapidly under carefully controlled conditions. The rate of cooling was adjusted so that the maximum tension which existed in the interior did not exceed a safe value, but the resulting strain distribution greatly increased the resistance to mechanical and electrical shock. The process was limited to comparatively simple shapes. The load required to break a strip of toughened glass was between four and five times that which would break a similar strip of annealed glass of the same composition, while the resistance to thermal "shock" was also higher owing to the initial high compression in the surface layers.

The electrical strength of glass was so high that there was no difficulty in designing an insulator which could not be punctured in air by voltage surges. The surfaces of toughened glass were initially in a state of compression. It was therefore possible to use it to produce an insulator capable of withstanding the maximum mechanical and thermal stresses normally encountered in service. Long life could be anticipated since, under service conditions, no surface cracks could develop in the compressed surface layers. As mechanical breakage or electrical puncture resulted in the complete shattering of the toughened glass, due to the release of stored potential energy, any insulator which was visibly whole was also mechanically and electrically sound. The choice of a suitable glass could be made with almost sole reference to its weathering qualities, as no compromise so far as electrical strength and ability to withstand mechanical and thermal shocks was necessary. The great resistance of toughened glass to thermal shock enabled a glass with a relatively high coefficient of expansion to be used. This had the advantage that its coefficient of expansion could be more nearly equal to that of the metal cap or pin. The glass chosen was of the lime-soda family and had a coefficient of linear expansion of $8{\cdot}7 \times 10^{-6}$ per deg. C.

The power-line insulators dealt with in the paper were composed of one-piece glass pressings in the smaller sizes, while in the case of the larger pin-type units they were made of a number of separate pressings, which were subsequently cemented together. The glass pieces required for a range of pin-type and cap-and-pin disc-type insulators were among the comparatively simple shapes which could be successfully pressed and toughened. Pressing was effected in a cast-iron mould with chill-hardened working surfaces and a plunger of the same material, at a temperature of about 1,000 deg. C. When the outer surfaces of the glass had set and the piece was sufficiently rigid to handle, the mould was opened and the glass placed in an equalising furnace at a temperature of about 700 deg. C. This furnace was of the revolving hearth electrically-heated type and was fitted with thermostatic control to ensure constant temperature. When the temperature had been equalised throughout, the piece was removed from the furnace and rapidly cooled by compressed air. The rate of cooling was adjusted to give a safe maximum tension in the central layer of the glass, and uniformity was obtained by close control of the time and temperature at each stage of the process. The cold toughened-glass pieces were then subjected to a thermal shock test by suddenly pushing them into a kiln at a temperature of 550 deg. C. and allowing them to remain there until the transient temperature gradient in the glass had passed through its maximum. The object of this test was temporarily to increase the tension in the central layer by the thermal expansion of the surface layers, and thus to weed out any defective piece. Next, the glasses were partially de-toughened by exposing them to a temperature of 450 deg. C. for the required length of time. This increased the factor of safety by slightly lowering the maximum tension in the central layer and completed the toughening process. In the finished insulator this tension was about 8,000 lb. per square inch. During the subsequent examination and gauging processes the transparency of the material enabled any internal fault to be easily seen. The component parts, metal and glass, were joined together by an aluminous cement without the use of any resilient medium. Every operation was jigged to ensure correct alignment of the parts. The pin-type insulators were fitted with copper or aluminium caps and screwed copper ferrules. The metal cap enabled the insulator to support the line mechanically should the top shed be broken and also raised the voltage at which radio interference started. Fig. 1 showed a 11-kV pin-type and Fig. 2 a 33-kV pin-type toughened-glass insulator, while the construction of an anti-fog suspension-type insulator and of a heavy-duty tension-type insulator of the same material would be clear from Figs. 3 and 4, respectively.

During the development period many preliminary and long-duration tests, some of which were still in progress, were made. The size of the fragments of a shattered insulator was some measure of the degree of toughening, and to determine this quality, samples taken continuously from manufacture were broken and compared with standards which had been established by experience. It was hoped eventually, however, to obtain sufficient data to enable the toughening process to be controlled by the routine use of a Babinet compensator. With this end in view, readings were taken of the sample pieces in this instrument and the results



were related with the fragmentation when the pieces were subsequently broken. After many preliminary tests an aluminous cement of high mechanical strength, which did not adhere to the glass, was adopted and had been justified by experience. The annular space between two concentric cylinders of strain-free glass was filled with the cement to be tested and the assembly placed in the open or exposed to controlled temperature and humidity conditions. Any stress in the cylinder was measured at intervals by a Babinet compensator. It was hoped that valuable information regarding the behaviour of cements over a long period of time would thus be obtained.

For the purpose of mechanical tests, a 10-in. diameter disc insulator with an ultimate tensile strength of 15,000 lb. was produced. When this was tested to destruction the metal fittings failed between 18,000 lb. and 20,000 lb., but in no case was the glass disc broken. A strengthened cap and pin were then fitted and loads up to 30,000 lb. were applied before the pin failed, but again no disc was broken. Four and a half years ago a string of discs with normal fittings was erected in the open under a constant load of 10,000 lb. The pins were slowly elongating, but all the discs were intact. Similar tests were being made with other insulators at 10,000 lb. and 20,000 lb., while in another case strings of 10,000 lb. disc insulators had been loaded to 4,000 lb. and kept in a state of continuous vibration. Some considerable time must, however, elapse before the results of these tests could be of much value. When toughened glass broke it shattered completely and tests were, therefore, made to determine the mechanical strengths of shattered tension insulators. In one test, a 10-in. diameter insulator was loaded to 10,000 lb. and the glass disc deliberately broken. This load was sustained for 5 minutes and then slowly increased until the pin failed between 18,000 lb. and 20,000 lb. The test was then repeated with the insulator under vibration, with the same result. A similar test was made on a 10-in. 28,000-lb. disc insulator, which was loaded to 12,000 lb. before the glass was broken. When the load was slowly increased failure occurred at 28,500 lb. owing to the cap and pin pulling through the broken glass. In the case of pin insulators, tests were made to ensure that the specified loads could be withstood without damage to the glass or appreciable permanent set in the spindle. Samples of the 11-kV and 33-kV insulators with a transverse load of 2,000 lb. applied to the side groove of the metal cap, were placed in the open in September, 1937, and had shown no relative movement of the parts, although the spindles had slowly bent. As the copper or aluminium caps were fitted on the insulators in order to support the line mechanically should the top shed of the insulator be broken, these tests were repeated after this shed had been shattered. In every case the spindle was bent before the cap was pulled off at loads up to 4,500 lb.

The results of power-frequency puncture tests on disc insulators completely immersed in "standard" insulating oil were very unsatisfactory. The puncture voltage was sometimes as low as 80 kV and in every case the insulator was punctured through the skirt, usually ½ in. to 1 in. beyond the edge of the cap. The use of a lignite tar oil with the addition of 5 per cent. of cable-box compound enabled 200 kV to be applied without puncture in over 80 per cent. of the cases. The results of puncture tests made on pin-type insulators under standard oil were better, but in the larger sizes puncture sometimes occurred through the skirts. In order to ascertain whether mechanically-overloaded glass disc insulators deteriorated electrically with time, eight 10-in. 15,000-lb. units were taken from a string which had been in the open for 4½ years under a load of 10,000 lb., and tested under lignite tar oil to which 2½ per cent. of cable compound had been added. Seven of the eight insulators remained unpunctured at 200 kV, while one punctured through the skirt at 185 kV. The result of this test confirmed that the compressed surface layer had succeeded in preventing the development of any incipient surface crack. A similar puncture test under the compound-treated oil was made on four 10-in. 15,000-lb. units taken from a string which had been loaded to 7,500 lb. in a thermal cycle for 2½ years. During this test the insulators had been subjected to over 4,800 cycles consisting of two hours heating in steam to 75 deg. F., followed by two hours cooling in artificial rain falling at the rate of 24 in. per hour. The average temperature of the water was about 11 deg. C. The four insulators remained unpunctured at 200 kV.

After preliminary tests had shown that the usually specified temperature-cycle tests with temperature changes up to 100 deg. C. could be easily met, it was decided to start a long duration test in which the most severe conditions could be reproduced. For this purpose a lead-lined wooden chamber with perforated steam pipes fitted at floor level and rain-spray nozzles in the roof was used. The insulators were supported on a trestle 21 in. above the floor. The steam supply was controlled by a magnetically operated valve, which, in turn, was controlled by a thermostat set to maintain the desired maximum temperature of 75 deg. C. The water-supply valve was adjusted to give the desired rate of rainfall of 24 in. per hour, and the heating and cooling periods, two hours each, were controlled by a time switch. Since the start of this test in October, 1935, over 7,800 cycles had been recorded. Temperature-distribution tests through the head of a multi-piece pin insulator showed that after 16 minutes cooling the temperature drop across the top shed rose to a maximum of 32 deg. C. because it acted as an umbrella and prevented the vertical rain from falling on to the lower sheds. This test confirmed the view that during the very heavy rain which usually followed a thunderstorm in the tropics, the temperature distribution through the head of a multi-piece pin insulator was such that considerable tension existed in the more rapidly cooled top shed. Simple 10-in. and 7-in. diameter disc insulators were still intact after 7,800 cycles, while some 10 in. insulators under a load of 7,500 lb. had withstood 4,800 cycles. The ability of the insulator to survive this test was undoubtedly due to the initial compression in the surface layers of the glass which was the unique feature of the toughened-glass insulator. Another long duration temperature-cycle test was started in November, 1937. In this test the insulators were immersed in water at room temperature for six hours and then placed in a refrigerating chamber for six hours, during which time the temperature of the atmosphere fell to −20 deg. C. The pin and disc type insulators were still intact after 1,400 cycles, including, in the case of the 10-in. diameter disc insulator, over 1,300 cycles under a load of 7,500 lb.

DIPLOMA IN ROAD TRANSPORT.—We understand that the Royal Society of Arts is to continue its examinations for administrative operative staffs of road-transport undertakings. All employees of motor-transport passenger and goods undertakings, in whatever capacity they are employed, are entitled to sit for the examination and to receive, if successful, the Diploma in Road Transport. There were 1,148 entries for the 1939 examinations, and those for the current year will be held from April 29 to May 9.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification in each case, is given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

518,065. Fowler Flap for Aircraft. Westland Aircraft, Limited, of Yeovil, and W. E. W. Petter, of Yeovil. (5 *Figs.*) April 22, 1938.—In the low-wing twin-engined aircraft shown, a Fowler flap *a* extends as one unit from under the fuselage *j* to points which are several feet outboard of the engine nacelles. The rear portion *b* of each engine nacelle fairing is attached to the flap and at the front end embodies a bulkhead to which is attached a wide hinge bracket by which this portion and the flap

Fig. 1.

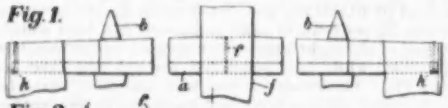


Fig. 2.

pivot as a unit about an axis low down in the fixed structure of the engine nacelle. Hydraulic rams in each nacelle working in unison cause the whole flap and fairing portion to swing open or shut. At the centre line of the fuselage *j* is a narrow track *f* on the flap which is in contact with a roller *g*. This relieves the flap of much of its load. For the same purpose, a roller *h* is fitted at each end of the flap in the trailing part of the main portion of the wing. (*Accepted February* 16, 1940.)

516,720. Wing-Flap Control. Phillips and Powis Aircraft, Limited, of Reading, and F. G. Miles, of Reading. (10 *Figs.*) May 3, 1938.—The invention is a control system which normally provides interlocking between the throttle and the flap-control levers and relieves both these levers of the necessary effort to keep the flaps locked in position. The broken lines show the fuselage 1 and monoplane wing system 2. The wing flaps 3 are operated by a double-acting piston in a cylinder 12 which is connected through a rotary-disc follow-up

Fig. 1.

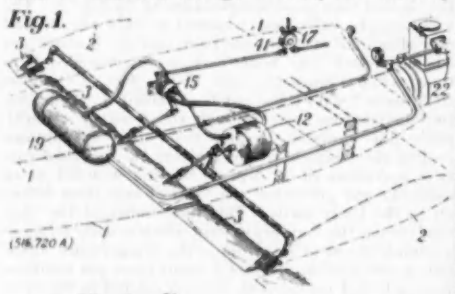
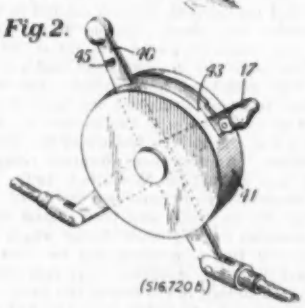


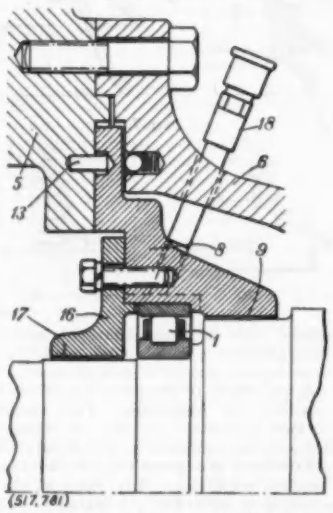
Fig. 2.



valve 15 to a vacuum reservoir 19, maintained at low pressure from the induction manifold 22 of the engine. One disc of the valve 15 is connected to a control lever 17 and the other disc to the centre section of the flaps. The follow-up valve 15 causes the movement of the flaps to correspond with the travel of the lever 17. The engine throttle lever 40 is mounted in a quadrant body 41 (Fig. 2). The flap lever 17 is mounted in the same fitting and on the same pivot. Both the levers operate in a quadrant slot which has a broader part accommodating both levers and a narrower part accommodating only the lever 17, which, however, is stopped in its forward movement by the shoulder 43 and only overrides it when the pilot deliberately presses it sideways. The position with lever 17 stopped by shoulder 43 corresponds to a flap position of maximum lift. Upon the lever 40 is a latch 45 to co-operate with a spring-loaded bolt carried by the lever 17. With the flap lever 17 fully forward and the flaps up, the throttle lever 40 simply controls engine speed. For take-off, the pilot moves the lever 17 backwards until it clicks over the shoulder 43, when the flaps are in the best position, and the lever 40 still has its normal travel unimpeded. In landing, the pilot pulls the throttle lever 40 back to the closed position, and then pulls back the lever 17 to maximum flap angle position and the spring bolt meets the latch 45. If, however, the pilot has to use his engine to regain height, he pushes the throttle lever forward in the normal way, and this entrains the lever 17 and pushes it forward also, automatically preventing the pilot from opening his throttle with the flaps down. Furthermore, the flaps are automatically returned to the maximum-lift position when the throttle is fully opened giving the most rapid ascent possible. (*Accepted January* 10, 1940.)

ELECTRICAL APPARATUS.

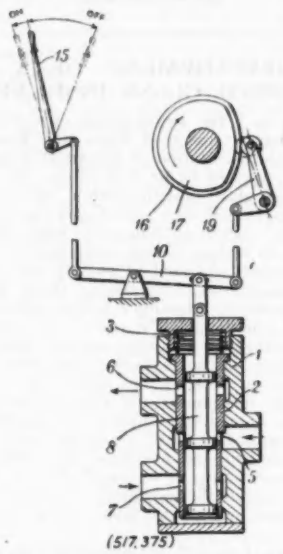
517,781. Flame-Proof Gland. The General Electric Company, Limited, of London, S. W. Richards, of London, and H. Worrall, of Witton. (2 *Figs.*) November 22, 1938.—The gland is for use in flame-proof dynamos and motors and is designed to allow for slight play in the shaft without damage to the gland or detriment to its effectiveness. The gland is floating and consists of a roller bearing 1 having its inner race fixed to the shaft of the motor near where it passes through the main casing 5 of the motor. The bearing, which is just outside the main casing, is enclosed by the end cover 6 of the motor. The outer race of the roller bearing is housed in an annular member 8 having a cylindrical surface 9 with a small clearance from the shaft of the motor on the side of the roller bearing remote from the casing 5 to form a flame-proof



path. A radial flange bears against the end of the main casing 5 to form a flame-proof joint. Pins 13, fixed in the casing 5, project into recesses of greater diameter to prevent the member 8 rotating with the shaft while allowing some radial play of the shaft. Spring-loaded balls in the end cover 6 maintain firm contact between the flange and the end of the casing. On the inner side of the roller bearing the annular member 8 carries a second annular member 16 also having a cylindrical surface with a small clearance from the shaft. An oil filler 18 enables the bearing to be oiled. Since the members 8 and 16 are positively located with respect to the shaft by the bearing 1, the clearance between the cylindrical surfaces 9 and 17 and the shaft can be reduced to a minimum. Radial play in the shaft will not damage the gland since it may move relatively to the main casing of the motor. (*Accepted February* 8, 1940.)

LIFTING AND HAULING APPLIANCES.

517,375. Pit Winding-Engine Brake. W. T. Bell and F. B. Perry, of Lincoln. (3 *Figs.*) June 24, 1938.—The brake is of the type in which the amount of braking available is variable according to the distance of the cage from the bank. A cylindrical valve body 1 has a sleeve 2 held in place by a helical spring 3 housed in a screwed bush. The sleeve has a central port 5 connected to the brake engines, an upper port 6 connected to the exhaust, and a lower port 7 connected to the compressed-air supply. A plunger 8 carries central, upper, and lower valves. The plunger is connected by a link to a rocking lever 10, the end on the opposite side of the pivot to the plunger link being connected to the driver's operating lever 15. The pressure in the brake engine is proportional to the position of the plunger 8 so that the braking force always corresponds to the position of the driver's lever. The upper and lower valves only prevent escape of air at the ends of the sleeve 2 and do not pass over the respective ports 6, 7. For a double winding drum system, two cam discs 16, 17 are mounted on a shaft rotated with the drum, the cam 16 being for balanced winding and the cam 17 for unbalanced winding. The lever 19 carrying the cam-follower roller can be slid on its shaft so that the roller engages one or other of the cams. This selection is effected by the operation of the clutch on the drum. The shaft on which the lever 19 is



mounted is also connected to the end of the lever 10 to which the plunger is connected. When the lever 15 is moved to apply the brakes, the lever 10 depresses the valve stem 8 so that the central valve moves over the port 5 and opens it to exhaust through the port 6. At the same time, the lever 19 is rocked towards the cams, and when the roller meets the appropriate cam further movement of the plunger 8 is prevented and the amount of braking that can be applied is restricted. The cams rotate approximately one revolution for each wind and are so profiled that the full braking force can be applied near the ends of the wind. Normally, the drums are clutched for balanced winding and the lever 19 is controlled only by the cam 16. A drum is only unclutched, giving unbalanced winding, to arrange for winding from a different level, in which case the unclutching slides the lever 19 so that it engages the cam 17. The cam 16 for the balanced winding is slightly larger over the whole of its periphery than the cam 17, so that the amount of braking possible is at all times less than with the cam 17. (*Accepted January* 29, 1940.)

MINING, METALLURGY, ETC.

512,538. Aluminium-Alloy Pistons. Ferranti, Limited, of Hollinwood, G. I. Finch, F.R.S., of London, J. Dawson and T. L. Houghton, of Hollinwood. July 8, 1938.—The invention is a process for manufacturing aluminium-alloy pistons. It is known that, in the case of certain aluminium-alloy pistons working in a steel cylinder liner, in spite of careful running-in, the liner becomes rapidly worn by the piston. It has now been discovered that the amorphous oxide layer on many aluminium-alloy working surfaces under heavy duty conditions becomes reconverted into a crystalline layer by the polishing action and that this layer has an abrasive effect. Further, whereas the amorphous layer formed on an aluminium surface is liable to this reconversion, the layer formed on an aluminium-magnesium alloy surface remains amorphous under any polishing action. By the new process, therefore, an internal-combustion engine piston of pure aluminium and machined to size is made the cathode in a porcelain bath of molten anhydrous salts consisting of magnesium chloride, 40 per cent. to 44 per cent.; sodium chloride, 22 per cent. to 26 per cent.; potassium chloride, 30 per cent. to 34 per cent.; and calcium fluoride, 0 per cent. to 2 per cent. The anode is magnesium. Electrolysis is carried out for 10 minutes to 30 minutes, at about 12 amperes per square foot current density, the bath being maintained at a temperature of about 500 deg. C. This produces a deposit of magnesium on the piston. The piston is then removed and quenched and again heated at a temperature of about 450 deg. C. for an hour, after which it is quenched once more and then machined to its original dimensions. The heat treatment causes the deposited magnesium to diffuse into the aluminium and form a layer of aluminium-magnesium alloy. The anodic treatment increases the amorphous layer of complex aluminium-magnesium oxide, which remains throughout the useful life of the piston despite "running-in" and heavy working conditions.—(*Accepted September* 19, 1939.)